TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Robson Valley Timber Supply Area Analysis Report

May 2000

BRITISH COLUMBIA

Ministry of Forests

Robson Valley Timber Supply Area Analysis Report

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Preface

This report contains a timber supply analysis and a socio-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. A review of each TSA and TFL is completed at least once every five years.

To determine allowable timber harvesting levels accurately and rationally, the chief forester must have an up-to-date assessment of the timber supply, based on the best available information and reflecting current management direction. **The report that follows provides this assessment but should not be construed as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the *Forest Practices Code (FPC) of B.C. Act* and official land-use decisions made by Cabinet.

Assessing the implications of only current practices rather than looking at a number of different management schemes will expedite the analysis process, allowing analysis of all TSAs in the province every five years. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the Chief Forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the Chief Forester with some of the information necessary for these considerations.

The socio-economic analysis considers forestry activity associated with the harvesting and processing of timber harvested from the TSA within the context of regional industry timber supply and production capacity.

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. (The first two documents are the information report and the data package). This document provides detailed technical information on the results of the timber supply and socio-economic analyses. A fourth document called the public discussion paper will summarize the technical information to provide a focus for public discussions of possible timber harvest levels. The fifth will outline the Chief Forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Robson Valley Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short- (next 20 years) and long- (next 250 years) term. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. **It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Robson Valley TSA covers about 1 236 000 hectares of area in the eastern portion of British Columbia. About 213 000 hectares of the area are considered available for timber production and harvesting under current management practices. Within the area available for timber harvesting, spruce is the most dominant species, although there are also significant areas dominated by lodgepole pine, balsam, cedar, hemlock and Douglas-fir species. Deciduous-leading stands are also considered available for harvesting by the forest industry in the area.

Current forest management practices follow the standards and legislation set out by the *Forest Practices Code*.

The results of this timber supply analysis suggest that the current AAC in the Robson Valley TSA (602 377 cubic metres per year) can be maintained for one decade without creating future timber shortages. This is followed by a reduction in the harvest level over the subsequent five decades to 340 000 cubic metres per year, which is maintained over the long term.

The above results reflect current knowledge and information on forest inventory, growth, and management. However, it is important to recognize that uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses show that these uncertainties can affect timber supply to varying degrees.

These sensitivity analyses show that, within the ranges examined, uncertainties do not require deviations from the short-term timber supply (next 20 years) as projected in the Robson Valley TSA base case. The uncertainties with the largest potential effects on projected harvests over the short term involve estimates of timber volumes in existing stands and the size of the timber harvesting land base.

Short-term timber supply would be reduced immediately if the existing stand volumes were 10% lower than expected or the timber harvesting land base were reduced by 10%. All other sensitivity analyses generally affected the harvest levels achievable in the medium (21 to 100 years from now) and long term (over 100 years from now).

A TSA-wide inventory audit conducted in 1998 shows that the volume estimates for mature stands (over 60 years old) based on inventory information are not statistically different from volumes derived using ground measurements. The audit therefore suggests that the inventory reasonably portrays the standing timber volume in existing stands, on average at the TSA level.

There is also no indication that the timber harvesting land base is different from that used in the base case analysis. Land base reductions resulting from the establishment of new protected areas are reflected in the base case analysis. If it could be demonstrated that harvesting can occur in areas classified as high quality caribou habitat, without degrading that habitat, then the timber harvesting land base would increase relative to the base case, and the harvest forecast might improve in the short term.

Factors having the largest potential effects on timber supply over the medium term include changes in harvest scheduling priority, decreases in managed stand yields, changes in forest cover requirements for management of visual quality, and old-growth site index adjustments, as well as the factors affecting short-term timber supply mentioned above. If stands are harvested more randomly than in the base case, the medium- and long-term harvest forecast is reduced significantly. If managed stand yields are 10% lower than predicted in the base case, the medium- and long-term harvest forecast is reduced. Visual quality guidelines apply to 29% of the timber harvesting land base and affect both the medium- and long-term timber supply. If the visual absorption capacities in the visually sensitive areas were lower or higher than modelled, medium- and long-term timber supply would be considerably different than shown for the base case.

Executive Summary

Medium-term timber supply is affected to a lesser extent by changing environmentally sensitive area reductions, changing minimum volumes for mature stand exclusions, changing the amount of wet subzone cedar-hemlock harvested, changing weevil loss estimates, increasing the amount of partial-cut harvesting, planting orchard seed, reducing the time to green-up, and applying longer regeneration delays.

Long-term (over 100 years from now) timber supply is affected by uncertainties in all the above factors with the exception of changes to existing stand yields. Reduction of non-recoverable losses could also impact long-term timber supply. Uncertainty regarding the productivity of old-forest stands had the largest effect on projected harvests in the medium- and long-term.

The socio-economic analysis for the Robson Valley TSA indicates that the current AAC of 602 377 cubic metres can support a provincial total of approximately 600 person-years of direct employment. Residents of the Robson Valley TSA account for about 70% of this direct employment. Direct forest sector activity in the TSA supports a further 730 person-years of indirect and induced employment across the province.

No reduction from the current AAC is forecast in the first decade; however, in the second decade the timber supply is forecast to decline by 10% to 542 139 cubic metres per year. According to current employment coefficients, this reduction in the timber supply would lower potential provincial employment to approximately 540 person-years of direct and 660 person-years of indirect and induced employment. Actual job impacts may not be as severe because recent harvest levels have been below the current AAC.

Reducing the annual harvest level by a further 10% to 487 925 cubic metres in the third decade would lower provincial employment to approximately 490 person-years of direct and 590 person-years of indirect and induced employment.

The current AAC provides the provincial government with average annual revenues of $19.8 million. Under the base case harvest forecast, reductions in the timber supply in the second and third decades could decrease annual revenues by about $2 million per decade.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions about whether a stand is available for harvest often depend on how its harvest could affect the growth and development of another part of the forest resource, such as wildlife or a recreation area.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time. Some of these factors are being examined in the current *Enhanced Forest Management Pilot Project* (EFMPP) in the Robson Valley TSA.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood. Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area) using a computer model. For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the Chief Forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units through British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 *of the* Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The B.C. Forest Service forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Robson Valley TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Timber supply analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. Section 6 summarizes the sensitivity analyses and is followed by conclusions for the timber supply analysis in Section 7.

Appendix A contains further details about the data and assumptions used in the timber supply analysis.

As part of the timber supply review, information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. Section 8 of this report describes the socio-economic analysis, which provides the chief forester with some of the information necessary for these considerations. The socio-economic analysis also provides information for the local community to better understand the potential magnitude of impacts associated with any harvest level changes.

Appendix B contains background information and some of the limitations of the socio-economic data.

Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Indirect and induced employment* figures were calculated using the Robson Valley TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Introduction

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions* and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as general indicators.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

1 Description of the Robson Valley Timber Supply Area

The Robson Valley Timber Supply Area (TSA) is situated in east-central British Columbia and covers approximately 1.2 million hectares. Located in the southeast portion of the Prince George Forest Region, the Robson Valley TSA coincides closely with the boundary of the Robson Valley Forest District, with the exception of Mount Robson Provincial Park. The TSA is administered from the forest district office located in McBride.

The Robson Valley TSA lies mainly in the Rocky Mountain trench, with the Cariboo and Monashee Mountains to the west, and the Rocky Mountains and Alberta border to the east. The TSA straddles the upper reaches of the Fraser River watershed* in the north and the Canoe River, a tributary of the Columbia River, in the south. The Robson Valley TSA is bordered by three provincial parks to the west (Wells Gray, Bowron Lake and the Mitchell Lake-Niagara protected area* that connects them) and by the Kakwa Recreation Area to the north. To the east are the Willmore Wilderness Area, Jasper National Park and Mount Robson and Mount Terry Fox Provincial Parks.

The terrain in the Robson Valley TSA is quite variable. The wide bottomlands of the Rocky Mountain trench are flat to rolling, while the adjacent snow-capped mountain ranges are rugged with steep forested slopes, deeply cut side valleys and fast-moving mountain streams. The diversity of landscape is reflected in a diversity of tree species, including the dominant spruce and subalpine fir, as well as western redcedar, lodgepole pine, western hemlock and Douglas-fir. Forests in this TSA are dominated by mature and older types.

The current allowable annual cut (AAC) for the Robson Valley TSA is 602 377 cubic metres, including 6000 cubic metres for harvesting of deciduous* stands. This level was set in 1996 and was unchanged from the previous AAC determination. As reported in this timber supply analysis report, about 43% of the TSA (about 535 000 hectares) is considered productive forest land. Approximately 40% of that productive forest (about 213 000 hectares) or 17% of the total TSA land base is considered available for harvesting under current management practices.

Significant changes that influence forest management in the Robson Valley TSA have occurred since the last timber supply review was completed. These changes include implementation of the *Forest Practices Code** and approval by the provincial government of the *Robson Valley Land and Resource Management Plan**, including new proposed protected areas. The management plan provides direction for the sustainable use of Crown land and resources in the Robson Valley area. The plan-developed through a local planning process and in consultation with various sectors–strives to balance economic, ecological, spiritual, recreational and cultural interests.

The largest communities in the Robson Valley TSA are McBride and Valemount, which are home to about 50% of the TSA's population of 4,080 people (1996 census). Other smaller communities include Crescent Spur-Loos, Dunster, Tete Jaune and Albreda.

Watershed
An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Deciduous
Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Land and Resource Management Plan (LRMP)
A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

1 Description of the Robson Valley Timber Supply Area

The forest land resources found in the Robson Valley TSA include timber, forage, water, fisheries, wildlife, scenic landscapes and outdoor recreation opportunities. Guide outfitting and trapping depend on the large mammals and fur-bearing animals common to the area. Recreational use of the forests by both residents and tourists is high due to the proximity of provincial and national parks and the exceptional natural scenery. The mountainous terrain, lakes and rivers of the TSA provide a wide range of outdoor recreation opportunities including hiking, camping, hunting, boating, mountain-biking, fishing, snowmobiling, and cross-country, telemark and heli-skiing.

1.1 The environment

The Robson Valley TSA is located in the interior wet-belt of the province and includes four biogeoclimatic zones*. These ecosystem units reflect distinct differences in terrain, climate and the species of trees that are present.

The sub-boreal spruce zone (SBS) is found at low elevations primarily in the Rocky Mountain trench. It is characterized by severe, snowy winters and relatively warm, moist and short summers. Annual precipitation is moderate. Hybrid white spruce and subalpine fir are the dominant climax* tree species in the sub-boreal spruce. Lodgepole pine, Douglas-fir, trembling aspen, paper birch and black cottonwood predominate in areas with extensive wildfire history.

The interior cedar-hemlock zone (ICH) occurs at lower to middle elevations, above the sub-boreal spruce. It is characterized by cool wet winters and warm moist summers, with a significant portion of precipitation occurring as snow. The forests of the interior cedar-hemlock have the highest diversity of any zone in B.C. Western redcedar and western hemlock dominate climax forests; other common species are hybrid white spruce, subalpine fir, Douglas-fir, lodgepole pine and black cottonwood.

Above the interior cedar-hemlock is the Engelmann spruce-subalpine fir zone (ESSF), the uppermost forested zone. The Engelmann spruce-subalpine fir has a relatively cold, moist and snowy climate. Growing seasons are cool and short, while winters are long and cold. Engelmann spruce and subalpine fir are the dominant climax tree species, as well, lodgepole pine and whitebark pine can also occur.

The alpine tundra zone (AT) occurs at the highest elevations, above the Engelmann spruce-subalpine fir. The harsh alpine climate of this zone is cold, windy and snowy, and is characterized by low growing season temperatures and a very short frost-free period. The alpine zone is, by definition, treeless but tree species are common at lower elevations of the zone, usually in stunted form. Alpine vegetation is dominated by shrubs, herbs, mosses and lichens, although much of the landscape lacks vegetation and is the domain of rock, ice and snow.

The Robson Valley TSA supports an abundance and wide variety of wildlife species, including more than 50 mammal species and more than 200 of British Columbia's 430 bird species. Ungulate populations in this TSA are limited by factors such as steep-sided valleys, high snowfalls, and the loss of summer and key winter range to agricultural development and the flooding of the Kinbasket Reservoir. Regionally significant populations of mountain goats occur in certain high elevation habitats adjacent to Mount Robson, and moose, mule deer, white-tailed deer and elk occur in valley bottoms. Small populations of woodland caribou are found in certain high elevation areas, black bears are common and relatively high densities of grizzly bears occur throughout many of the drainages in the TSA.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

Climax forest
A forest community that represents the final stage of natural forest succession.

1 Description of the Robson Valley Timber Supply Area

Although no large natural lakes exist in the Robson Valley TSA, a number of small lakes provide recreational trout fishing opportunities. Little information on the abundance and distribution of fish stocks in these lakes is available. Several sites within the TSA are Class A fish habitat, including the Fraser River and all its tributaries. Bull trout habitat exists in many creeks, significant chinook salmon spawning areas occur in a number of drainages, and rainbow trout and mountain whitefish are also common.

The majority of species that are considered at risk or regionally significant and that occur or potentially may be found in the Robson Valley TSA are presented in Table 1.

Table 1. Vulnerable, endangered and threatened species

Endangered or threatened (red-listed)	Vulnerable (blue-listed)
White sturgeon (Fraser River population)	Short-eared owl American bittern bull trout *luscus* wolverine fisher northern long-eared myotis Rocky Mtn. Bighorn sheep grizzly bear

Source: B.C. Conservation Data Centre, November 1, 1998.

Current forest management practices follow the legislation and guidelines set out by the *Forest Practices Code*. Consequently, the protection of wildlife and the environment will be managed through the *Code*. In addition, the *Robson Valley Land and Resource Management Plan* provides further direction on landscape units, biodiversity emphasis objectives, enhanced riparian buffer zones around water intakes and major rivers, enhanced protection of ungulate winter range, access management strategies to protect wildlife populations, and the use of partial cutting to enhance visual quality in the main valley. Proposed protected areas also include key wildlife habitat areas.

Future increases in harvesting activities and road access in certain portions of the Robson Valley TSA remain a concern, for both fisheries and wildlife values. Fragmentation of habitat is also an issue, particularly in the southern portion of the TSA.

1.2 First Nations

There are no First Nations communities in the Robson Valley TSA. However, five First Nations assert territorial interests in the Robson Valley TSA: the Lheidli T'enneh Nation and the North Thompson Band assert traditional territory that covers the entire TSA, and the Canim Lake, Williams Lake and Red Bluff bands assert territorial interests that cover portions of the TSA.

An Archaeological Overview Assessment (AOA) for the Robson Valley TSA was completed in 1995 for the *Robson Valley Land and Resource Management Plan*. This AOA is the basis for determining areas and sites that may require further assessment in the form of an Archaeological Impact Assessment (AIA). AIAs are carried out as part of operational planning. The findings of AIAs that have been completed will be considered in this timber supply review.

1 Description of the Robson Valley Timber Supply Area

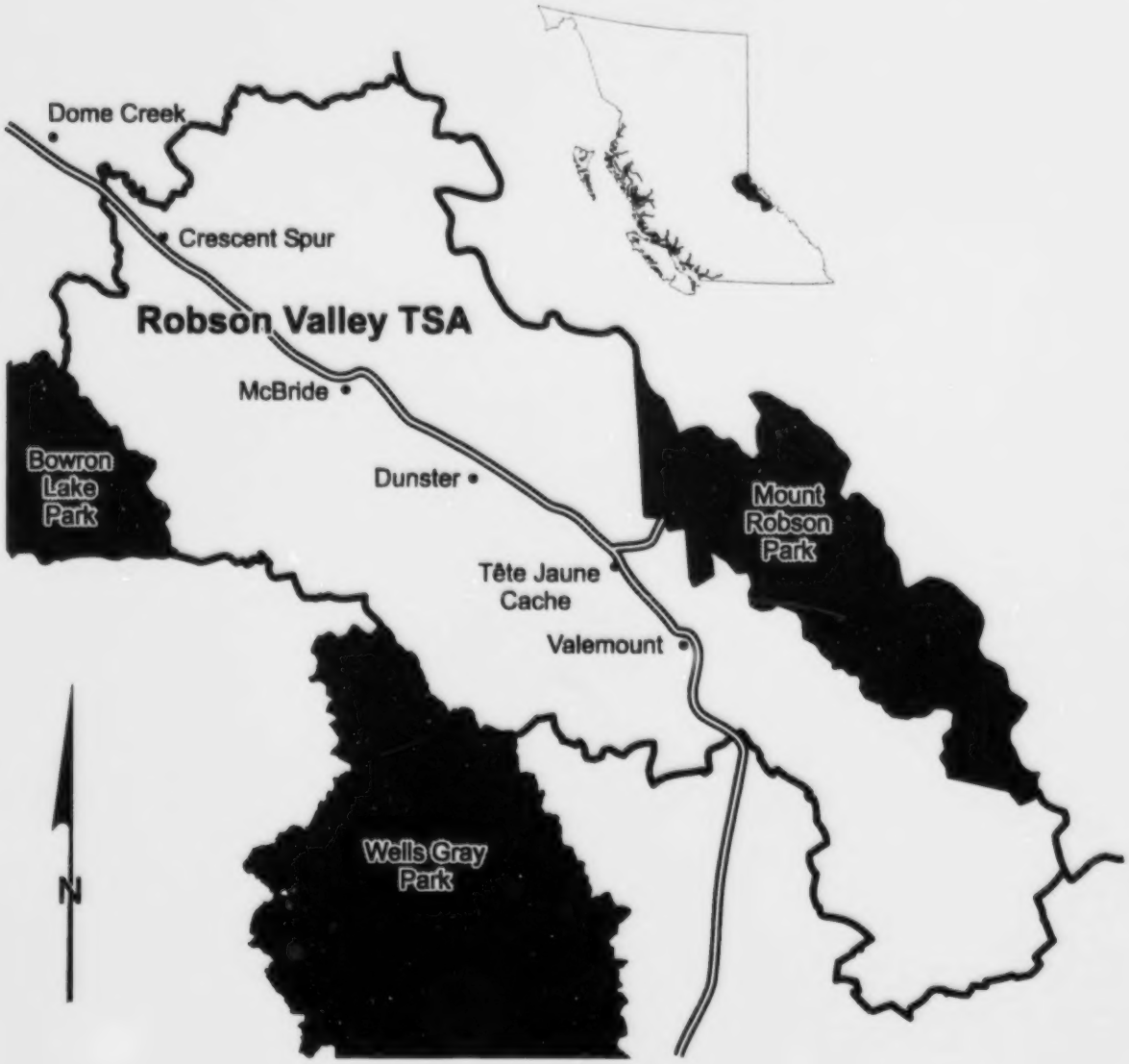

Figure 1. Map of the Robson Valley Timber Supply Area, Prince George Forest Region.

2 Information Preparation for the Timber Supply Analysis

Much information is required for timber supply analysis. This information can be divided into three general categories: land base inventory; timber growth and yield; and management practices.

2.1 Land base inventory

The various sources of land base information used in this analysis were compiled into one computer file in 1999 by the Ministry of Forests, Robson Valley Forest District. This file contains information on the forest land in the Robson Valley TSA including general geographic location, area, nature of forest cover (such as number and type of trees, age, and timber volume), and other characteristics such as environmental sensitivity and physical accessibility (operability*). Stand attributes such as tree height, stocking* and age have been projected to 1998. The inventory file has been updated to account for timber harvesting up to 1998 for the Robson Valley TSA.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, areas in utility and transportation corridors, and residential and industrial development.

A description of these areas specific to the Robson Valley TSA is provided below. These types of areas do not contribute to the timber harvesting land base* of the Robson Valley TSA. Before assessing timber supply, these non-contributing areas are identified and separated from the timber harvesting land base. When deriving this data file, care is taken to make only a single reduction for areas which overlap (for example, where an inoperable area is also wildlife habitat).

Identifying areas as not contributing to timber supply does not mean they are removed from the Robson Valley TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mixture of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

This section describes the types of areas that do not contribute to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

Timber harvesting land base
Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.

2 Information Preparation for the Timber Supply Analysis

For the Robson Valley TSA, the following types of areas were excluded from the timber harvesting land base.

- not managed by the B.C. Forest Service — these are non-Crown areas and parks removed from the TSA. The forested portions of parks and reserves (e.g., ecological reserves) contribute towards biodiversity* values.
- non-forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons.
- environmentally sensitive areas* — portions of the areas considered environmentally sensitive and/or significantly valuable for other resources.
- sites with low timber productivity — areas occupied by forest with low timber-growing potential.
- non-merchantable and low volume stands — stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability.
- riparian areas* — areas entirely or partially reserved from harvesting to provide protection for riparian and stream ecosystems.
- inaccessible areas — areas of forest land that cannot be harvested due to excessive logging costs.
- high value recreation areas.
- essential caribou habitat areas — no timber harvesting is permitted in areas designated as high quality for Caribou habitat.
- grizzly bear habitat areas — no timber harvesting is permitted in grizzly bear habitat areas.
- existing roads, trails and landings — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- wildlife tree* patch areas — areas reserved within and along the edges of cutblocks* for the maintenance of stand-level biodiversity* (stand structure), primarily for conservation or enhancement of wildlife.
- protected areas — ten new areas have been designated as protected under the approved *Robson Valley Land and Resource Management Plan* and are excluded from timber harvesting.

Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.

Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Cutblock
A specific area, with defined boundaries, authorized for harvest.

Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category, and shows the area of the timber harvesting land base. The column "Crown forest area by classification" provides the total forest area managed by the B.C. Forest Service within the given category. For example, while there is a total of 155 531 hectares of forested land classified as environmentally sensitive area (ESA), only 120 955 hectares were removed specifically due to environmental sensitivity. The difference arises because one area can be in more than one classification (e.g., inoperable and ESA), and the actual area deducted depends on the point at which the reduction occurs in the sequence. Further, partial reductions are sometimes employed to represent situations where parts of areas are retained to protect a particular value.

The current timber harvesting land base in the Robson Valley TSA represents about 17% of the total TSA area and about 40% of the forest area managed by the B.C. Forest Service. The categories which most reduce the availability of the productive forest for timber supply are: inoperable areas (10.6%) and environmentally sensitive areas (22.6%). The remaining deducted categories, such as riparian areas, represent 26.9% of the productive forest. The percentages provided depend on the order in which each class is considered. For instance, riparian areas would constitute a larger proportion of the reduction if they were considered prior to inoperable areas.

The current timber harvesting land base is 4018 hectares (1.9%) bigger than in the last timber supply review. Had the protected areas not been established the timber harvesting land base would have been 17 115 hectares (8.2%) bigger than in the last timber supply review. This is due to both a new forest cover inventory and new operability mapping.

2 Information Preparation for the Timber Supply Analysis

Table 2. Determination of the timber harvesting land base for the Robson Valley TSA

Classification	Crown forest area by classification	Area (hectares)	Per cent of total TSA area	Per cent of Crown forest land
Total TSA area		1 236 227		
Land not managed by the B.C. Forest Service or water bodies		42 374		
Non-productive forest		658 487		
Total productive forest managed by the B.C. Forest Service (Crown forest)		**535 366**	**43.3**	**100.0**
Reductions to the Crown forest available for timber supply				
Non-commercial brush	687	687	0.1	0.1
Inoperable areas	56 991	56 928	4.6	10.6
Environmentally sensitive areas	155 531	120 955	9.8	22.6
Sites exhibiting low productivity	25 247	11 907	1.0	2.2
Non-merchantable mature stands	91 294	34 454	2.8	6.4
Stands with low volume	74 411	15 495	1.3	2.9
Riparian reserves	46 469	25 601	2.1	4.8
Inaccessible areas	4 474	1 146	0.1	0.2
Areas with high value for recreation	7 876	2 668	0.2	0.5
Essential caribou habitat	66 610	26 460	2.1	4.9
Grizzly habitat	5 354	2 288	0.2	0.4
Existing unclassified roads	7 976	5 628	0.5	1.1
Wildlife tree patches	10 707	4 669	0.4	0.9
Protected areas removed (new)	34 808	13 097	1.1	2.4
Total reductions		**321 983**	**26.0**	**60.1**
Current timber harvesting land base (including NSR*)		**213 383**	**17.3**	**39.9**
Future reductions				
Future roads trails and landings		12 129	1.0	2.3
Future timber harvesting land base		**201 254**	**16.3**	**37.6**

Notes: Used net NSR figure off inventory file. NSR = 5220 hectares (1410 hectares backlog, 3810 hectares current).

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

Figure 2 represents the total Robson Valley TSA area. Of the total area about 57% is classified as not managed by B.C. Forest Service, or is non-forest. Of the forested land in the Robson Valley TSA, about 60% is considered to be unavailable for harvesting. The main reasons for forest unavailability are physical or economic inoperability and environmental sensitivity. Approximately 40% of the Crown forest land is considered available for timber harvesting.

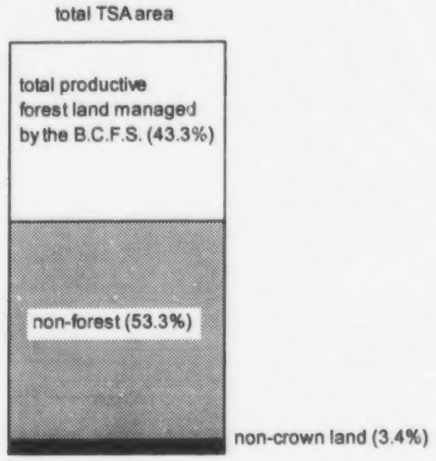

Figure 2. Composition of the total land base — Robson Valley TSA, 2000.

Figure 3 shows an overview of the proportion of the timber harvesting land base comprised by each biogeoclimatic (BEC) variant. For example, the ESSFmm1 variant makes up 41.7% of the timber harvesting land base. In addition the figure also indicates the proportion of the variant outside the timber harvesting land base. Using the ESSFmm1 example, 63.5% of the total area within the variant is found outside the timber harvesting land base. This number gives an indication of the amount of area, outside the timber harvesting land base, that can assist in meeting forest cover requirements.

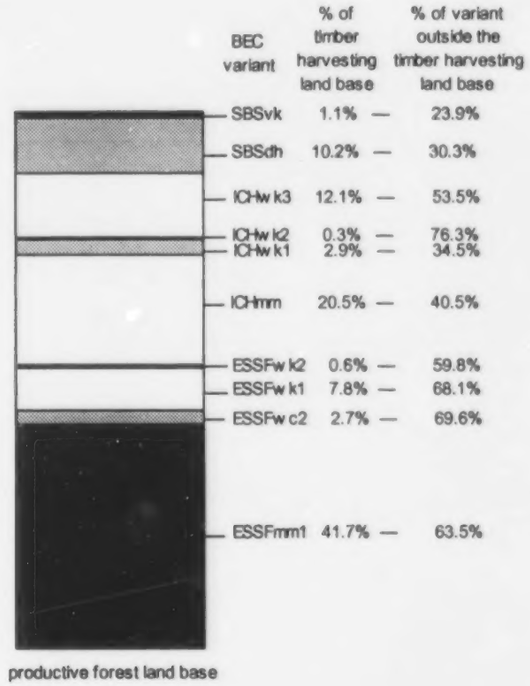

Figure 3. Area by biogeoclimatic classification on the productive forest area — Robson Valley TSA, 2000.

2 Information Preparation for the Timber Supply Analysis

Figure 4 shows the current composition of the timber harvesting land base by dominant tree species. Spruce dominates within the timber harvesting land base followed by balsam, pine, cedar, Douglas-fir, hemlock, and deciduous species. After harvest, all stands are expected to be regenerated to the same species which occupied the site previously.

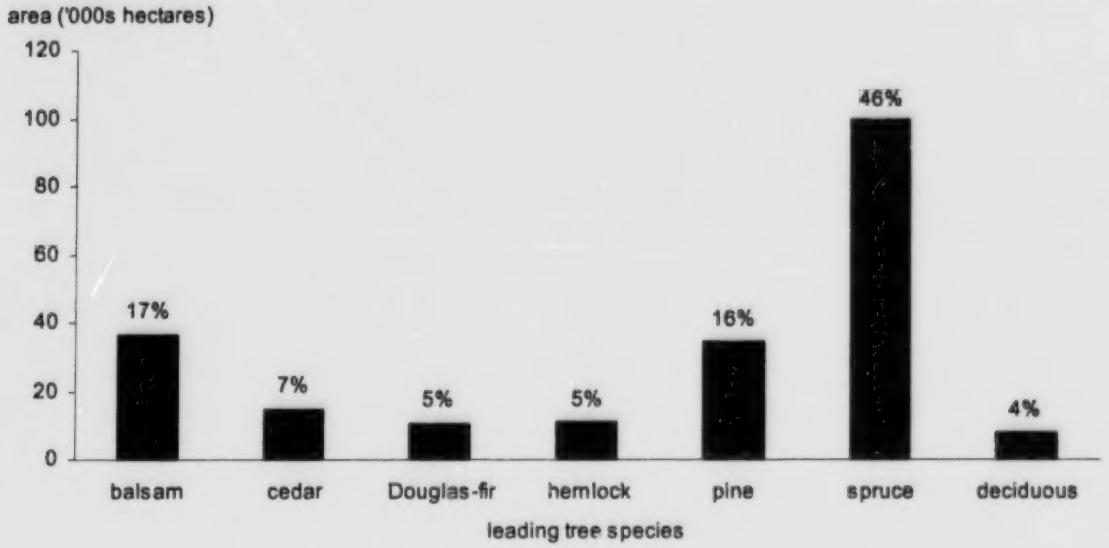

Figure 4. Area by species — Robson Valley TSA timber harvesting land base, 2000.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the proportion of area for each species that has a management history and the amount of area over and under 140 years of age. In total, about 14% of stands in the timber harvesting land base have a history of logging and subsequent management treatments, the other 86% of stands generally have yet to be harvested and therefore have no management history. Very little logging and subsequent management has occurred in cedar and hemlock stands, while spruce stands have a more extensive management history.

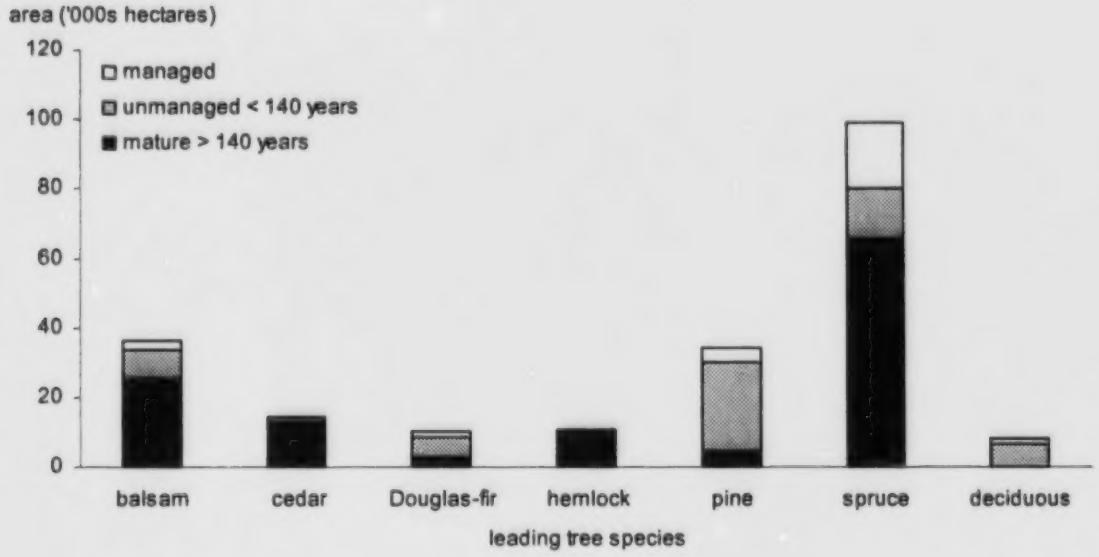

Figure 5. Area by age classification — Robson Valley TSA timber harvesting land base, 2000.

For the total timber harvesting land base, about 57% of the area is occupied by stands over 140 years of age. There is variation around these proportions for each of the species groupings: cedar and hemlock stands are predominately older than 140 years of age. Pine, Douglas-fir and deciduous species tend to be younger then 140 years of age, likely due to the frequency of fire where these species are common.

Figure 6 provides an overview of the distribution of site productivity of the dominant stand types within the timber harvesting land base. Twenty per cent of the stands are classified as having relatively good site productivity. Stands with moderate site productivity occupy 59% of the area, and those with a relatively low site productivity, 21%. Sites of very low productivity are excluded from the timber harvesting land base.

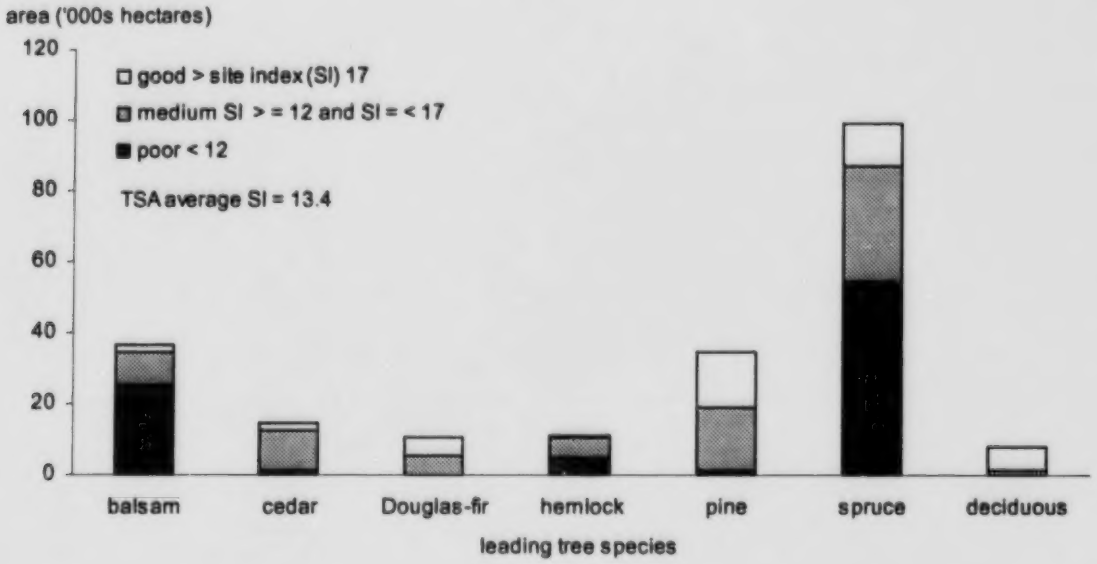

Figure 6. Area by predominant species and site productivity — Robson Valley TSA timber harvesting land base, 2000.

Figure 7 shows the current age composition of all Crown forested area and timber harvesting land base in the Robson Valley TSA. There is a large range in age of stands in the Robson Valley TSA and stands are well distributed across that range.

For the timber harvesting land base, about 13% of stands are 20 years or younger, 21% are between 21 and 100 years old, 51% are between 101 and 250 years of age and 26% are older then 250 years.

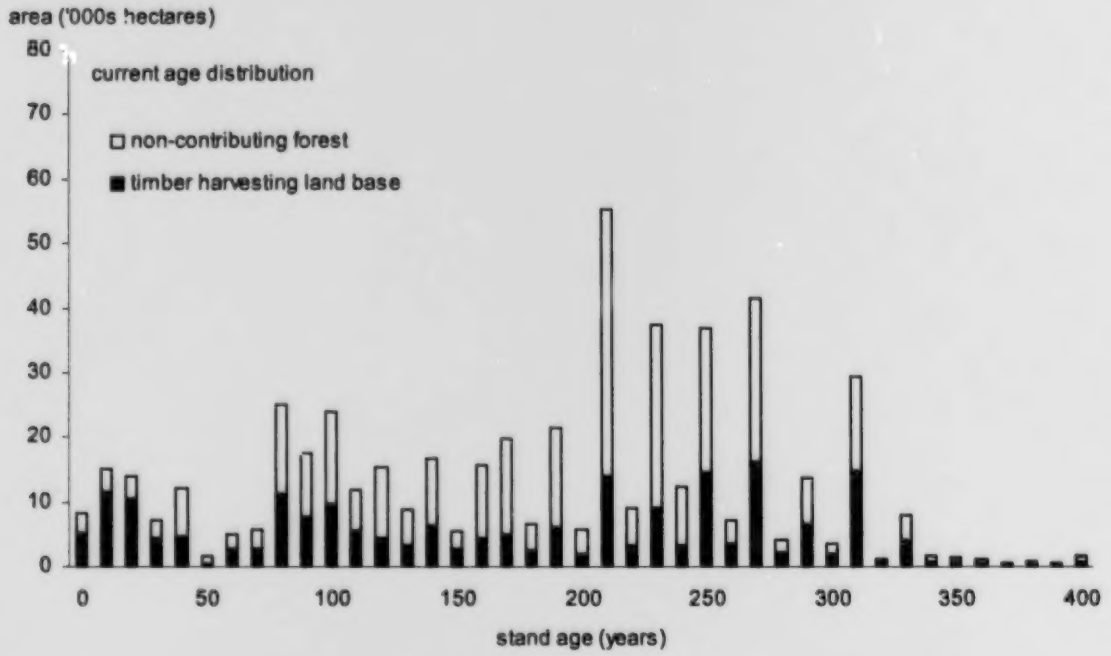

Figure 7. Current age class composition — Robson Valley TSA forested land base and timber harvesting land base, 2000.

In the Robson Valley TSA, 60% of the total forest land base of 535 366 hectares is covered by stands which are excluded from timber harvesting but nevertheless contribute indirectly to the timber supply. These inoperable stands affect how much harvesting can be conducted and the pattern of the harvesting within the TSA by providing old-forest and biodiversity attributes. About 20% of these non-contributing stands are older than 250 years. Only 3% of the stands are 20 years or younger, 17% are between 21 and 100 years old, and 59% are between 101 and 250 years of age.

2.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of forest stands over time. Forest stands have many characteristics that change over time that could be the subject of growth and yield (e.g., number of trees per area, tree diameter, tree height, species composition). Since timber supply analysis concentrates on timber volumes available over time, the most relevant measure for this analysis is volume per area (in British Columbia, cubic metres per hectare). An estimate of timber volume in a stand assumes a specific utilization level, or set of dimensions, that establish the minimum tree and log sizes that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree.

Two growth and yield models were used to estimate timber volumes for the Robson Valley TSA analysis. The variable density yield prediction (VDYP version 6.5a) model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in unmanaged coniferous* stands and all deciduous stands. The table interpolation program for stand yields (batch TIPSY version 2.1 alpha5), developed by the B.C. Forest Service, Research Branch was used to estimate yields for coniferous managed stands. Managed stands were defined as all stands less than 10 years old, 95% of stands 11 to 20 years of age and 83% of stands 21 to 30 years of age; and all coniferous stands established in the future.

Volume estimation and prediction is subject to uncertainty due to inaccuracies in inventories which form the basis for estimating site productivity, limited experience with second-growth in British Columbia, and the long time frame over which trees grow. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates*, the current timber inventory on the timber harvesting land base is approximately 51 million cubic metres. About 49 million cubic metres, or 96%, of the total are currently merchantable; that is, older than minimum harvestable age.

Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.

2 Information Preparation for the Timber Supply Analysis

2.3 Management practices

Timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The *Forest Practices Code of British Columbia Act* and associated regulations guide forest management practices in the Robson Valley TSA. The focus of the Timber Supply Review is to assess timber supply based on current management practices as implemented in plans for the area. Staff in the Robson Valley Forest District provided descriptions for the following current management practices:

- Silviculture practices — reforestation activities required to establish free-growing* stands of acceptable tree species. Most areas in the Robson Valley TSA are harvested using a clearcut harvesting* system and restocked by planting.
- Incremental silviculture —currently all spruce stands are planted using orchard seedlings in the Robson Valley TSA.
- Forest health and unsalvaged losses* — timber losses to fire and pest (insect) damage are expected to average 92 604 cubic metres per year, with the majority of the loss related to insects loss (hemlock looper) and fire. These losses are assumed to remain at this level indefinitely.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Cutblock adjacency* and green-up* — in the Robson Valley TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (three metres in height for integrated resource management* area), before adjacent stands may be harvested. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time. These guidelines were modelled by limiting the areas that do not meet green-up conditions to a maximum of 33% in the integrated resource management (IRM) area within each landscape unit.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Clearcut harvesting
A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding.
Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.

Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Integrated resource management
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

- Caribou habitat protection was modelled by ensuring that at least 33% of the area identified as caribou medium habitat was covered by forest greater than 80 years old and at least 20% of the area identified as caribou corridor habitat was covered by forest greater than 100 years old. There were also provisions that no more than 33% of caribou medium and 20% of caribou corridor habitat forest could be less than three metres tall.
- Grizzly bear habitat protection is addressed through a land base netdown. See Section 2, "Information Preparation for the Timber Supply Analysis."
- Protection of environmentally sensitive areas (ESAs) — to maintain ecological or other resource values, land classified as ESA was partially or wholly removed from the timber harvesting land base. Of the total of 155 531 hectares identified as ESAs, only 16% remain in the timber harvesting land base after all the area reductions.
- Community watersheds — community watersheds are allowed to have a maximum of 5% of the area below the green-up height of three metres. Community watersheds cover only 1% of the timber harvesting land base and may overlap with areas managed for other values such as wildlife habitat or scenic values.
- Maintenance of scenic values — maintaining important scenic values requires that visible evidence of harvesting be kept within limits in some areas of the Robson Valley TSA. The maximum proportion of each scenic area* that may be covered by stands less then five metres varies depending on the forest characteristics and the visual quality objectives (VQO)* for each area, but generally ranges between 1% and 21%.
- Minimum harvestable ages (MHA) — the time it takes for stands to grow to a merchantable condition. The criteria used to define minimum harvestable ages were that stands should have a volume of at least 140 cubic metres per hectare on areas harvestable with conventional logging equipment, 200 cubic metres per hectare on areas operable for a mix of cable and conventional logging and 250 cubic metres per hectare on areas only harvestable with cable logging systems. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other available stands, forest cover objectives* and overall timber harvest targets.

Scenic area
Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green-up).

- Landscape-level biodiversity* — to maintain biological diversity throughout a landscape unit*, the *Forest Practices Code* contains targets for the proportion of the area in each biogeoclimatic variant* that should be covered by stands with old-forest characteristics. The Robson Valley Forest District has defined draft landscape units and biodiversity emphasis options for biogeoclimatic variants within the Robson Valley TSA.

The data package for the Robson Valley Timber Supply Area (TSA) was released in December 1998. As a result of public input, changes were required to the data package (e.g., added sensitivity analysis* around regeneration delay*). The revised data package, which includes detailed descriptions of the management practices and the assumptions used to incorporate them into the analysis, is presented in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" of this document.

Landscape-level biodiversity
The Forest Practices Code Biodiversity Guidebook *provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.*
Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Sensitivity analysis
A process that examines how uncertainty in data and management assumptions affect timber supply.
Regeneration delay
The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.

2 Information Preparation for the Timber Supply Analysis

Figure 8 displays the proportions of the timber harvesting land base subject to different management emphases. Since some areas are subject to more than one management objective, the percentages add to more than 100%. For example, an area managed for caribou habitat emphasis may also assist in meeting the forest cover requirements* for integrated resource management.

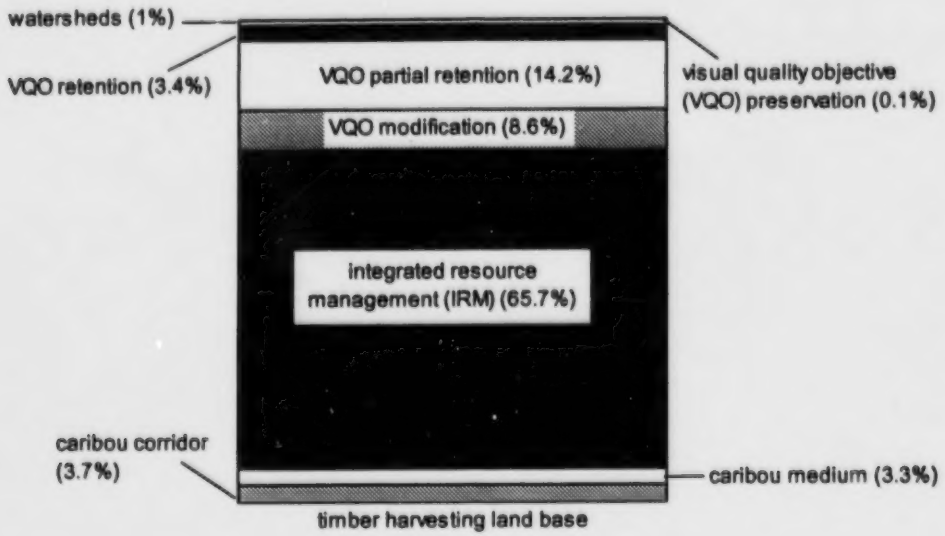

Figure 8. Timber harvesting land base by management emphasis — Robson Valley TSA timber harvesting land base, 2000.

Forest cover requirements
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green-up).

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Robson Valley TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service was used to aid in the assessment (FSSIM version 3.0). A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (collection of stands) could be managed to obtain a harvest forecast* (supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes, and the management regime to represent how trees grow and are harvested over a long period of time. Generally, only the results for the first 250 years are shown graphically in this report because the harvest level remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age, or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model facilitates examination of the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implications of a particular forest management regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only very limited guidance in the design of operational activities, such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports rather than hinders sustainable forest management in the field.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

4 Results

This section presents results of the timber supply analysis for the Robson Valley TSA. The base case harvest forecast uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." Because forest management is inherently a long-term venture, uncertainty surrounds much of the information important in determining timber supply. This uncertainty will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The base case provides only a part of the timber supply picture for the Robson Valley TSA, and should not be viewed in isolation of the sensitivity analysis.

4.1 Base case and alternative flow harvest forecasts

Figure 9 shows the base case harvest forecast* for the Robson Valley TSA. This analysis suggests that the current AAC of 602 377 cubic metres per year can be maintained for one decade followed by a reduction in the harvest level over the subsequent six decades to 340 000 cubic metres per year. The harvest level of 340 000 cubic metres per year remains constant over the long term.

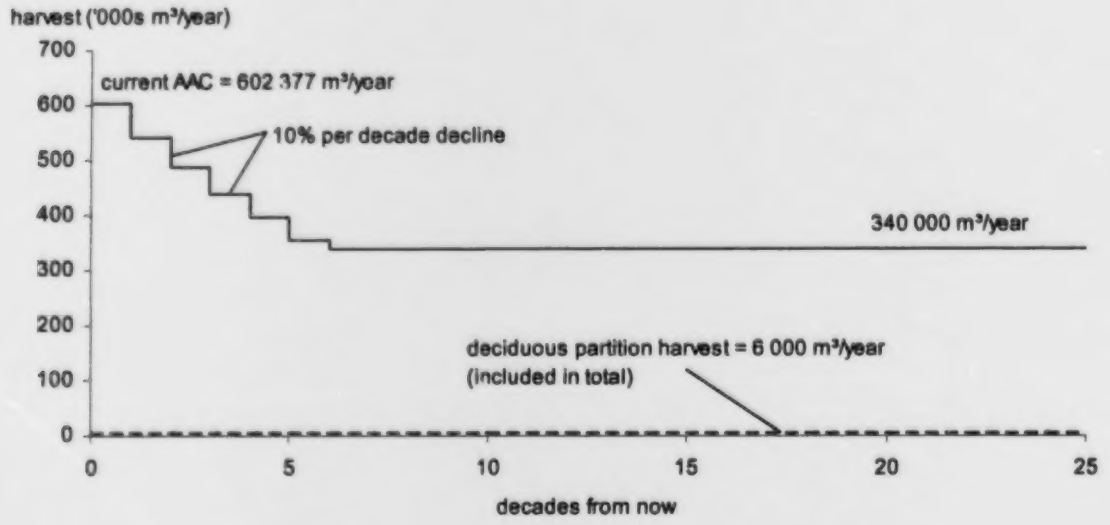

Figure 9. Base case harvest forecast for the Robson Valley TSA, 2000.

Unsalvaged losses due to natural forces such as insects and fire are estimated to be 92 604 cubic metres per year for the entire planning horizon and have been subtracted from all harvest forecasts shown in this report. The harvest forecast includes 6000 cubic metres per year of deciduous harvest, for the entire planning horizon. Forest District staff have requested that the deciduous harvest be partitioned* from the coniferous harvest when the allowable annual cut is determined.

Base case forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

Partition
A portion of the AAC that is attributable to certain types of timber and/or terrain.

4 Results

Several harvest forecasts are possible for the Robson Valley TSA within the current management regime described in Section 2, "Information Preparation for the Timber Supply Analysis." Prior to selecting the base case, a number of forecasts were developed to analyse the potential timber supply for the Robson Valley TSA. Figure 10 presents some of these forecasts, and the following paragraphs describe how the alternative forecasts were evaluated, and how the final selection of the base case harvest forecast was made.

The first forecast tested the feasibility of maintaining the current harvest for as long as possible without causing severe timber shortages in the future. Results show that it is possible to maintain the current harvest for two decades before declining to a long-term harvest level* of 336 000 cubic metres per year, or 4000 cubic metres per year less then the base case. Under this forecast, growing stock* is about 10% lower over the long term compared to the base case.

The second forecast tested the impact of maintaining the current harvest for longer than two decades. Results show that maintaining the current harvest for any longer than two decades reduces the long-term harvest level further and creates a dip in the harvest forecast at decade 11. The impact of holding the current harvest level for four decades is shown on Figure 10. The harvest forecast is reduced to 288 115 cubic metres per year in decade 11 and recovers to 313 000 cubic metres per year in the long term, or 27 000 cubic metres less than the base case, due to a significant depletion of the growing stock.

A third alternative tested the feasibility of lowering the harvest immediately by 10% to 542 139 cubic metres per year (not shown). It was possible to maintain this harvest level for three decades before following the same harvest projection as shown in the base case. For the first three decades, this forecast projects a harvest of 60 238 cubic metres less than in the base case.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

Growing stock
The volume estimate for all standing timber at a particular time.

4 Results

The base case provides for an orderly transition from harvesting existing natural stands to future managed stands without sacrificing the long-term timber supply. Should the land base of the Robson Valley TSA be further reduced, stands be harvested in a more random manner, or future studies confirm that managed stands are growing better than projected, in this analysis, the base case forecast provides some flexibility to absorb these changes. This will be further be discussed in Section 5, "Timber Supply Sensitivity Analyses."

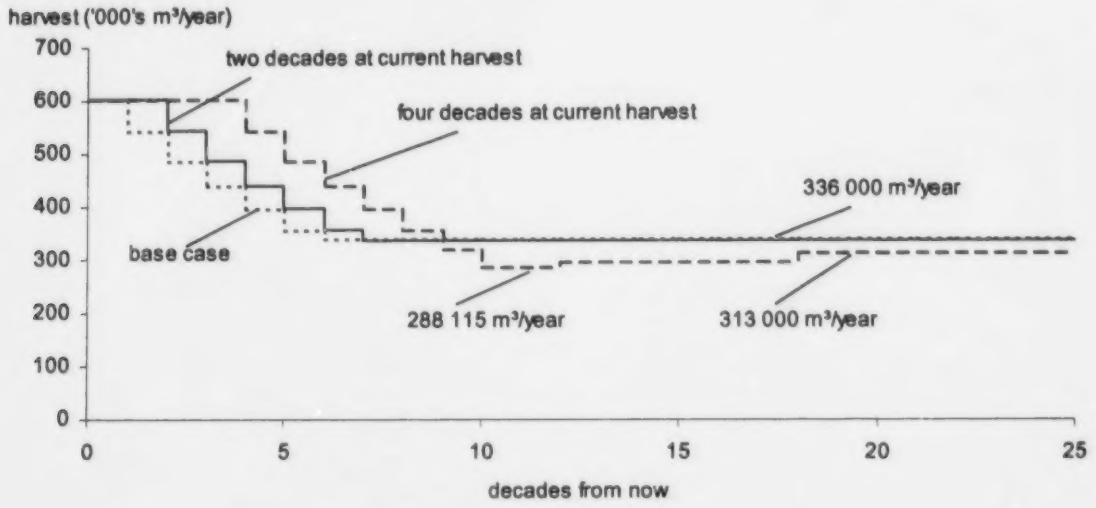

Figure 10. Alternative harvest flows — Robson Valley TSA, 2000.

4.1.1 Base case timber supply dynamics

As shown in Figure 7, the forest in both the timber harvesting land base and the non-timber harvesting land base is fairly well-distributed across all age classes. Figure 11 shows that this distribution enables a smooth transition of harvest from existing natural stands to managed stands for the base case. The transition from existing to managed stands starts at decade 11 and by decade 13 the contribution from managed stands comprises more than two-thirds of the total harvest from the TSA. By decade 16, managed stands contribute about 90% of the harvest.

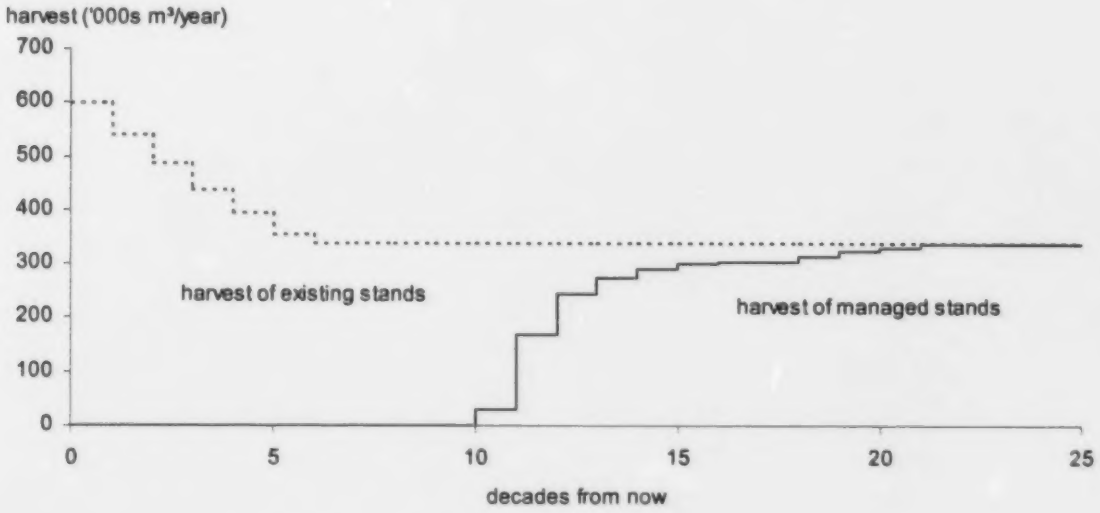

Figure 11. Harvest contribution from the unmanaged and managed stands — Robson Valley TSA, 2000.

If the current harvest is maintained for more than one decade, harvesting of managed stands begins sooner and less optimally from a volume growth perspective. The long-term harvest level is reduced as a result.

4 Results

Figure 12 tracks the growing stock from all stands and those that are merchantable. Almost all stands are merchantable initially, due to the predominance of older unmanaged stands. The merchantable growing stock remains high relative to the total base case harvest forecast due to the relatively low minimum harvestable ages (less than culmination of mean annual increment*). There is sufficient merchantable timber from unmanaged stands to maintain the long-term harvest level after decade 6, even though at that time managed stands are not being harvested. Existing unmanaged stands still contribute to the merchantable growing stock well into the future, largely because of the slow rate of harvest from retention and partial-retention visual quality areas on the timber harvesting land base.

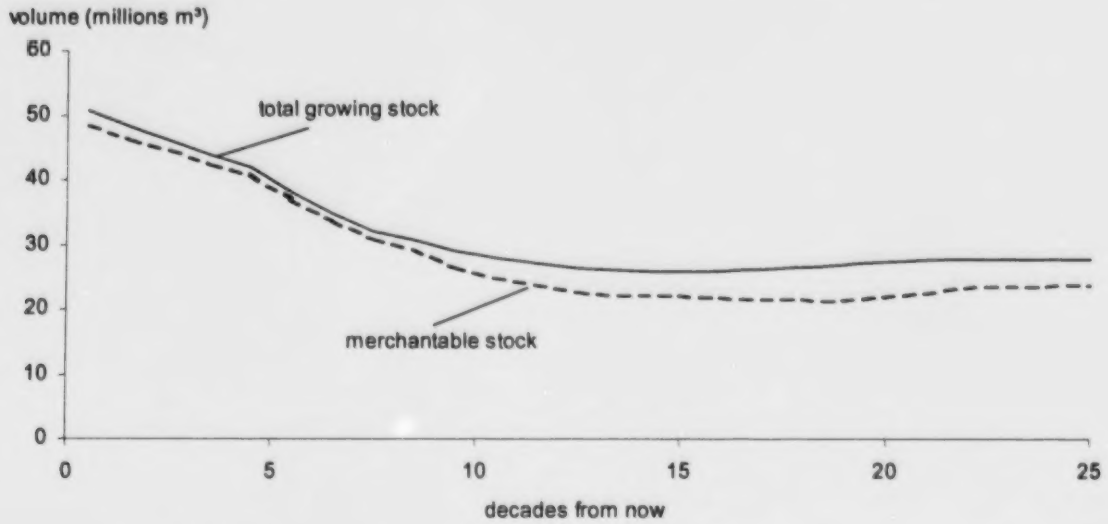

Figure 12. Total and merchantable growing stocks — Robson Valley TSA, 2000.

Mean annual increment (MAI)
Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

4 Results

4.2 Average age, area, and volume harvested

Figure 13 tracks the change in the area-weighted average harvest age resulting from the base case forecast. There is a gradual decline in average harvest age until decade 13, due to the harvesting of unmanaged stands, starting with the oldest ones first, after which it stabilizes. Decade 13 marks the transition of harvesting from predominantly unmanaged stands to managed stands, and thus the average harvest age remains fairly constant after this point.

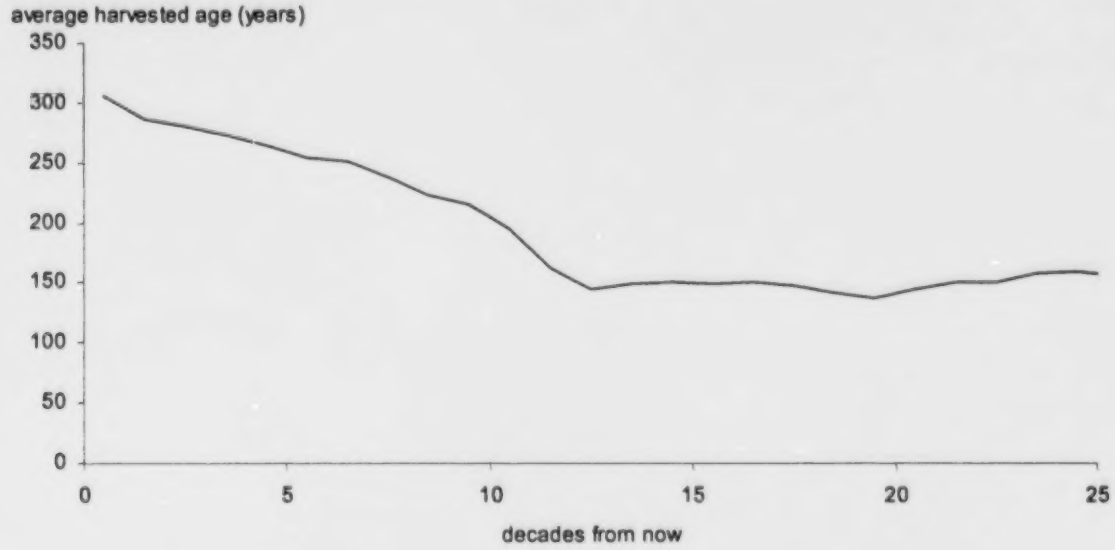

Figure 13. Average age of stands harvested over time — Robson Valley TSA base case, 2000.

4 Results

Figure 14 shows the average volume harvested per hectare and average area harvested per year over the next 250 years under the base case harvest forecast. For the first six decades the average area harvested declines from about 1750 hectares per year to about 1300 hectares per year, corresponding to the decline in base case harvest levels over this period. From decade 7 onward, the area harvested fluctuates around 1305 hectares per year. Average volume harvested per hectare also declines over the first five decades, as the oldest stands with the highest volumes are harvested first. An average volume of 340 cubic metres per hectare was harvested over the full planning horizon. The increase in average volume per hectare harvested in decade 12, corresponds to a decrease in average area harvested as the harvest level is constant after decade 7. Timing of availability of areas subject to different forest cover requirements can also lead to fluctuations in area and volume harvested.

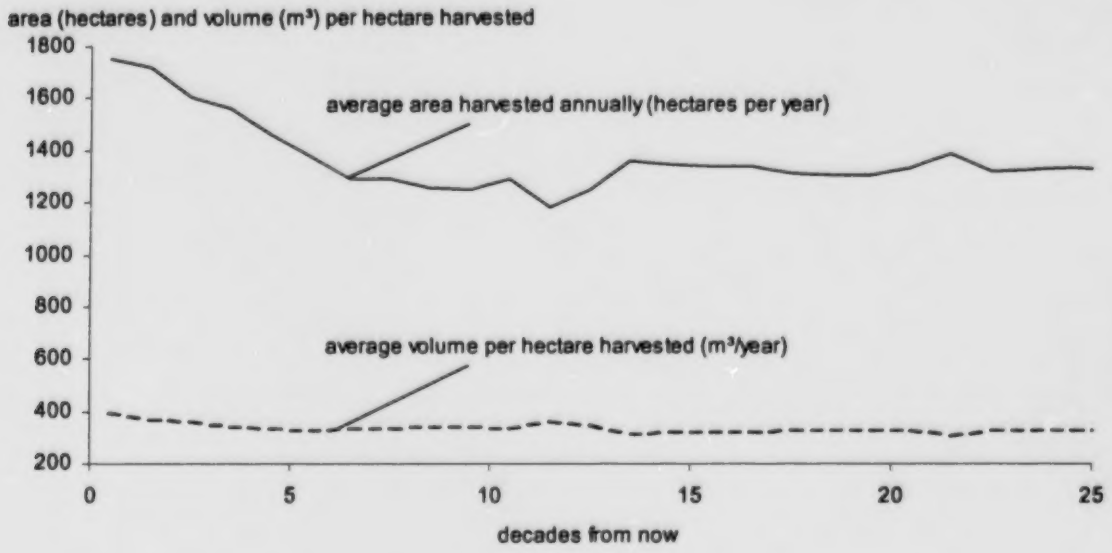

Figure 14. Average area harvested and average volume per hectare harvested over time — Robson Valley TSA base case, 2000.

4 Results

Figure 15 shows the average area harvested per year under the base case harvest forecast, for areas subject to forest cover requirements for integrated resource management and those areas subject to forest cover requirements for visual quality. It should be noted that harvesting in visually sensitive areas occurs over the entire forecast, but is greatest in decades 8 to 11, just prior to the transition from harvesting predominantly unmanaged stands to managed. For decades 8 to 11, between 30% and 40% of the area harvested is located in visually sensitive areas.

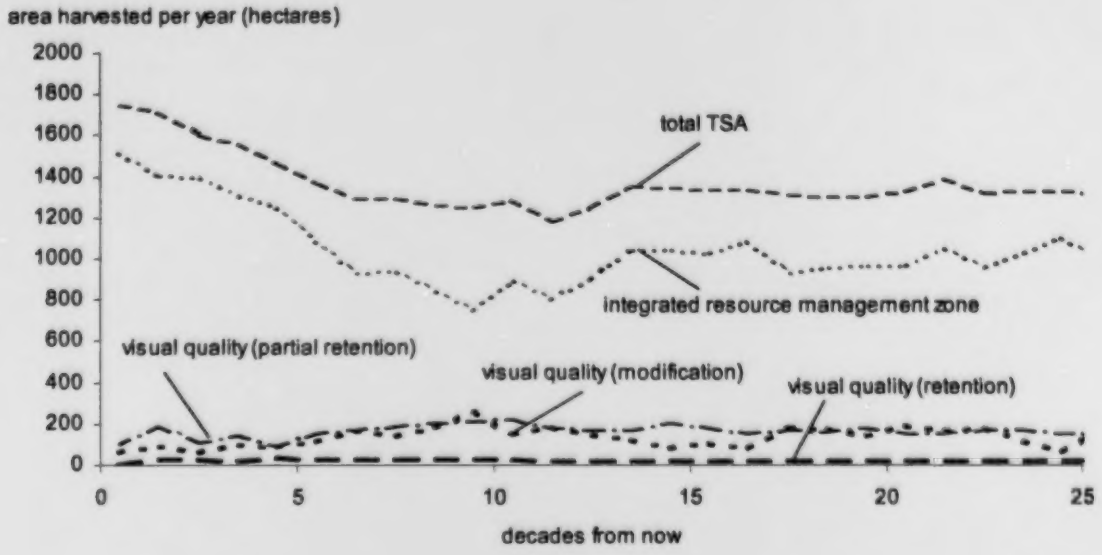

Figure 15. Average area harvested per hectare over time from areas subject to different forest over constraints — Robson Valley TSA base case, 2000.

4.3 Change in age class profile over time

The current age class distribution (Figure 7) shows that stands within the timber harvesting land base are fairly well distributed across all age classes. Outside of the timber harvesting land base the stands are also well distributed across all age classes with significant amounts currently less than 130 years. These younger stands exist largely due to fire, disease and insect out-breaks and past harvesting practices prior to the *Forest Practices Code*. For example, in the past, some harvesting may have occurred in riparian areas that are now deducted from the timber harvesting land base.

With a significant proportion of stands, greater then 250 years, outside of the timber harvesting land base, much of the old-growth requirements for landscape-level biodiversity are met without impacting stands within the timber harvesting land base. For a small area of the TSA where old forest is initially lacking for some biogeoclimatic variant and landscape units combinations, the forest estate model used by the B.C. Forest Service reserves enough of the older forest from the timber harvesting land base needed to meet old-growth objectives, until stands outside the timber harvesting land base can meet the requirements.

The chart in Figure 16 shows the changes in the age composition of the forest both in the timber harvesting land base and in the non-timber harvesting land base of the Robson Valley TSA over 150 years under the base case harvest forecast. Approximately 150 years from now, stands within the timber harvesting land base will be predominantly less than 150 years of age, since most would have been harvested at least once. Stands outside the timber harvesting land base will be generally over 150 years as the forest estate model does not model forest succession or fire events.

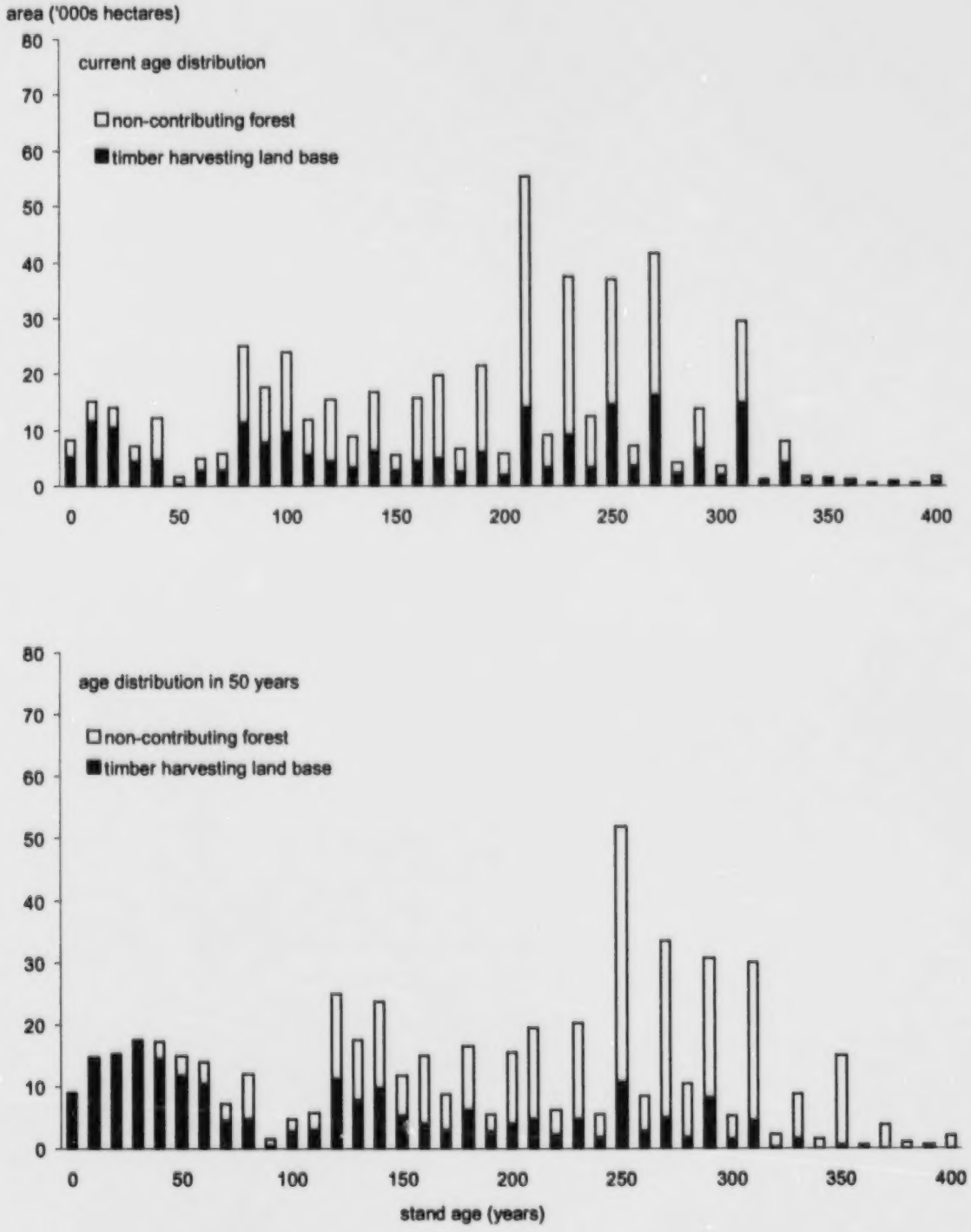

Figure 16. Changes in age class distribution over time — Robson Valley TSA forested land base and timber harvesting land base, 2000.

(continued)

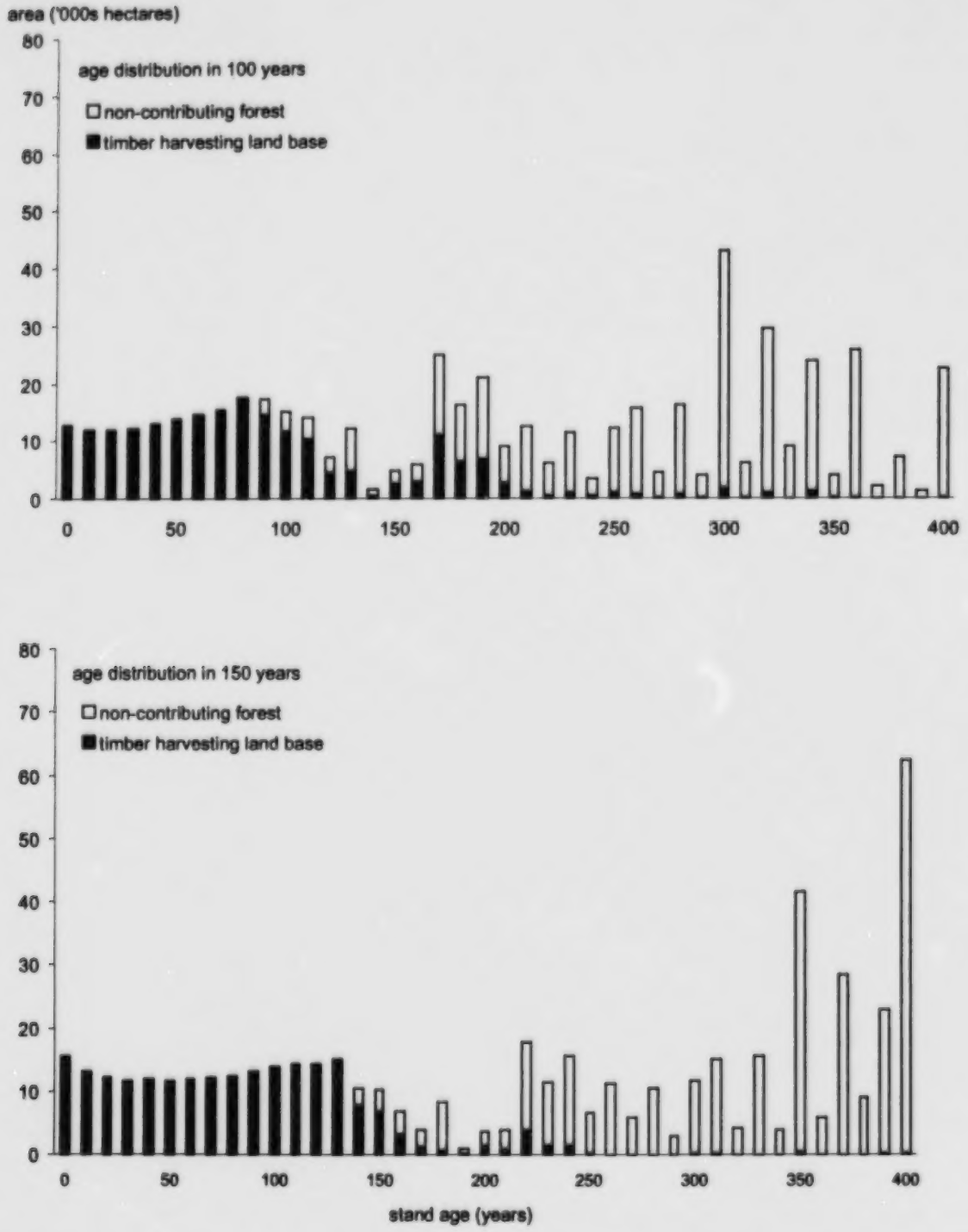

Figure 16. Changes in age class distribution over time — Robson Valley TSA forested land base and timber harvesting land base, 2000.

(concluded)

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management is a complicated and ever-changing endeavor that must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, which means that decisions we make today have not only short-term but also long-term effects. In such a context, we cannot be certain that all the data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision–making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities, that become apparent from new information, are not missed.

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide a safe basis for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of a number of sensitivity analyses are discussed. Sensitivity analyses are intended primarily to test the relative change (i.e., high *versus* low sensitivity) in the harvest forecast resulting from changes in forest management assumptions and data used in the base case.

For this analysis, short-term timber supply refers to the first 20 years, medium term refers to 21 to 100 years from now and the long-term timber supply is more then 100 years from now. The short- and medium-term timber supply is defined by existing stand yields and the long-term timber supply is defined by yields from managed stands.

5 Timber Supply Sensitivity Analyses

5.1 Uncertainty in the estimated area of the timber harvesting land base

Uncertainty in the estimated size of the timber harvesting land base is due to factors such as fluctuations in timber prices, changes in harvesting and milling technology, and land-use decisions.

There is also uncertainty around extrapolating information from a subset of mapsheets to the TSA as a whole. For example, detailed assessments of areas affected by riparian management were carried out on four mapsheets and the results extrapolated to the timber harvesting land base for the whole Robson Valley TSA. Currently it is not possible to assess whether the timber harvesting land base has been over- or under-estimated, however, two sensitivity analyses were carried out to show the impact of increasing and decreasing the timber harvesting land base. Figure 17 shows the impact of a 10% increase and decrease in the timber harvesting land base, with the changes concentrated in poor stand types to approximate the impact of operability changes.

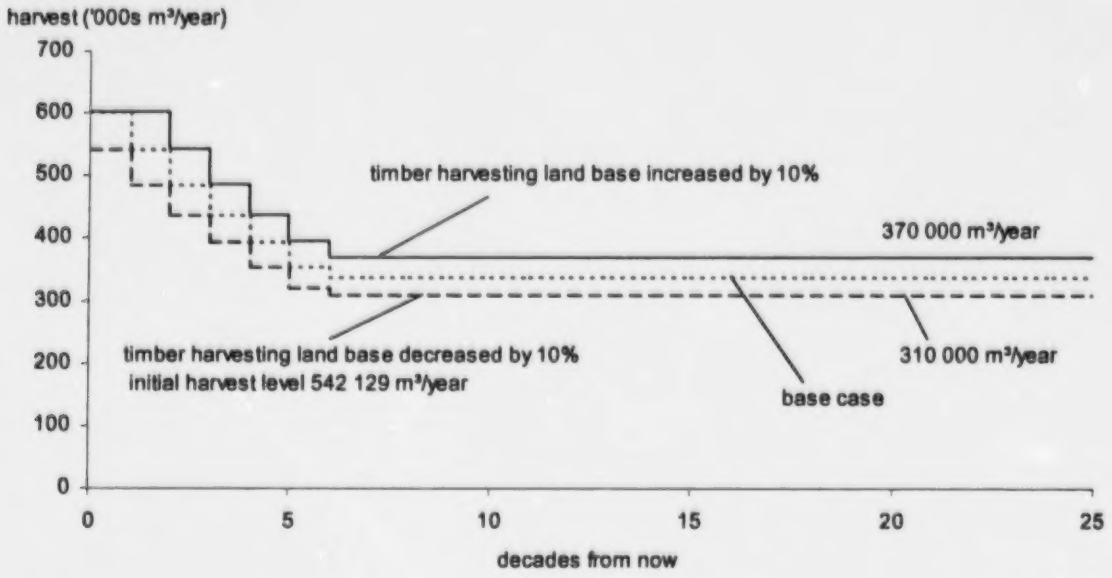

Figure 17. Land base sensitivity analysis — Robson Valley TSA, 2000.

The sensitivity analysis shows that if the base case over-estimated the timber harvesting land base, there is immediate impact, with the initial harvest dropping 10% and remaining approximately 9% lower than in the base case through the medium- and long-term. If the timber harvesting land base is larger than in the base case, the addition of more existing stands permits the current harvest level to be maintained for two decades before following a similar pattern as shown for the base case to a new long-term harvest level 9% above that of the base case.

5.2 Impact of newly established protected areas

The *Robson Valley Land and Resource Management Plan* (LRMP) includes the designation of ten new protected areas, which had a net effect of reducing the timber harvesting land base by 13 097 hectares (6.1%). The LRMP has been approved by government (not yet recognized by Order-in-Council as of April 2000) and as a result, the protected areas were removed from the timber harvesting land base in the base case. To show the impact of these removals, a sensitivity analysis was completed which included these areas in the timber harvesting land base. Figure 18 shows the effect on total timber supply had the protected areas not been established.

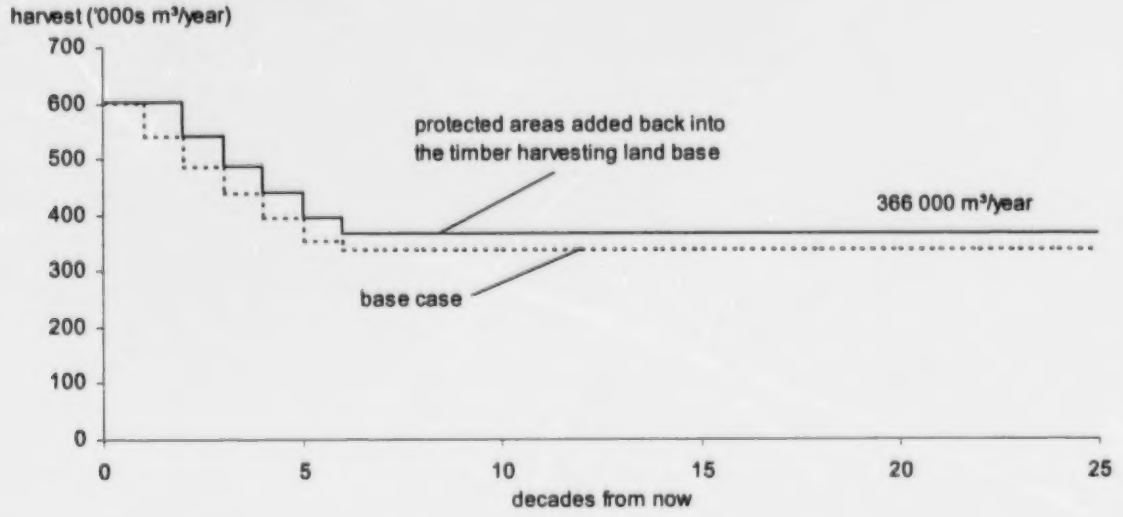

Figure 18. The effect of not removing protected areas from the timber harvesting land base — Robson Valley TSA, 2000.

With this addition to the timber harvesting land base, the initial harvest level can be maintained for two decades, rather than one, followed by 10% decreases through decade seven. The harvest level from decade seven onward is projected to be 26 000 cubic metres per year, or 7.6% higher than that of the base case.

Although it appears that a 6.1% land base increase has resulted in a 7.6 % increase in the medium- and long-term harvest forecast, or a larger volume increase than area increase, this is actually not the case. Volume increase is expressed as a percentage change from the base case harvest forecast after unsalvaged losses. If the volume increase is calculated using total timber supply prior to the reduction for unsalvaged losses, the change in volume is 6.0%, or about the same as the area increase. Thus the volume change is proportional to the land base change.

For most land base sensitivity analyses, the per cent volume change from the base case harvest forecast will be expressed both before and after unsalvaged losses.

5.3 Impact of changing the area reductions for environmentally sensitive areas

Forest lands that are environmentally sensitive and/or significantly valuable for other resources are identified in the inventory and called environmentally sensitive areas (ESAs). ESAs generally have restrictions on harvesting, which are accounted for in the base case by removing a portion or all of the area in an ESA during the determination of the timber harvesting land base. ESA area reductions are expressed as a reduction percentage for each ESA category and vary by ESA category from 10% to 100% reduction (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," for more details).

In this sensitivity analysis, the base case reductions were varied by ten percentage points for all ESA categories (100% ESA reductions were not increased beyond this level) to see the impact on the base case harvest forecast. Figure 19 shows the harvest level impact of a ten percentage point increase or decrease in the ESA area reduction percentages.

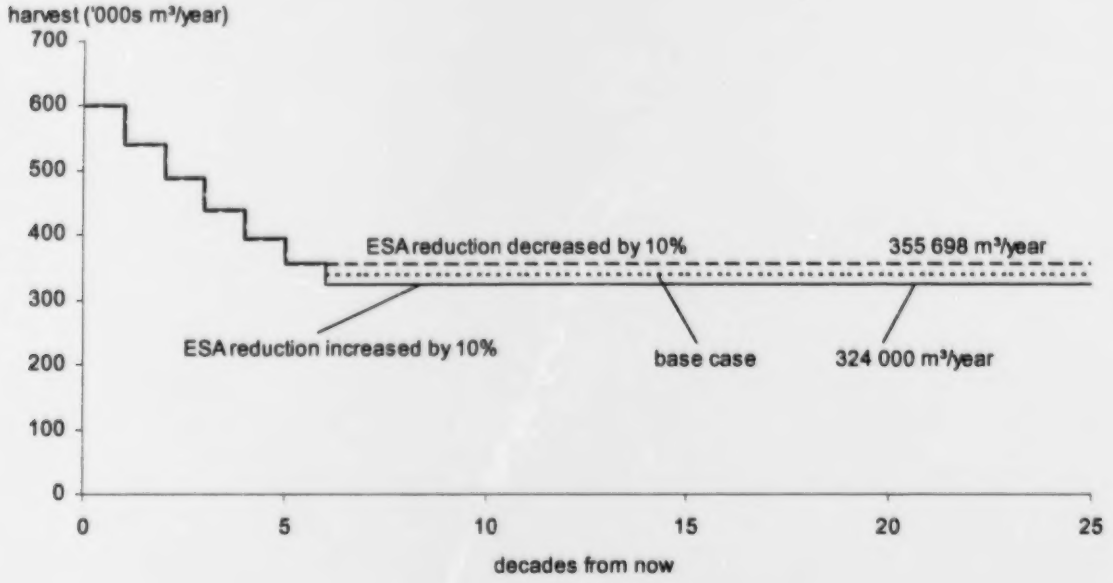

Figure 19. Harvest forecast if environmentally sensitive area reductions are changed — Robson Valley TSA, 2000.

Modified ESA reductions affect both medium- and long-term harvest levels. Had ESA reductions been ten percentage points higher than in the base case, the long-term harvest level would have been 16 000 cubic metres less (3.7%, before and 4.7% after reductions for unsalvaged losses) than in the base case. The timber harvesting hand base is reduced 3.75% due to the increased ESA reductions. Had ESA reduction percentages been ten percentage points lower than in the base case, the long-term harvest level would have been 15 700 cubic metres more (3.6%, before, and 4.6% after reductions for unsalvaged losses) than in the base case. The timber harvesting land base is increased 3.7% due to the decreased ESA reductions. The volume increase or decrease in the long-term harvest level is proportional to the percentage change in the timber harvesting land base.

5.4 Impact of changing mature stand minimum volume exclusions

For mature stands to be considered for harvesting, and be part of the timber harvesting land base, they had to have a specified minimum volume by 140 years of age. This minimum volume varied depending on the type of logging equipment that was required to harvest a stand, varying from 140 to 250 cubic metres per hectare.

In this sensitivity analysis, the minimum volume for each stand and logging equipment combination was increased and decreased by 50 cubic metres per hectare, which resulted in a decreased or increased timber harvesting land base. Figure 20 shows the impact on the timber supply of increasing and decreasing the minimum volume for mature stands by 50 cubic metres.

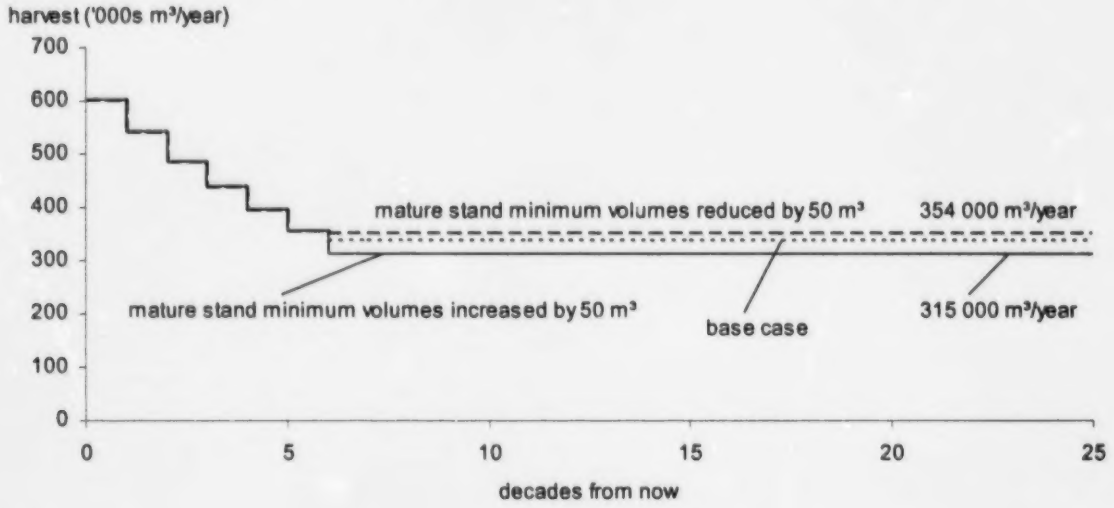

Figure 20. The effect of changing mature stand minimum volumes — Robson Valley TSA, 2000.

The timber harvesting land base is 14 914 hectares (6.8%) smaller and 8118 hectares (3.8%) larger if the minimum mature volume is increased and decreased by 50 cubic metres per hectare, respectively. Increasing the minimum mature stand volume by 50 cubic metres reduced timber supply to 315 000 cubic metres per year, or a 6% decrease, starting in decade seven. Decreasing the mature stand minimum volumes 50 cubic metres increased the harvest level to 354 000 cubic metres per year, or a 3.2% increase, starting in decade seven.

5.5 Impact of removing some areas in the Crown land plan

Approximately 14 500 hectares of timber harvesting land base is designated into one of thirteen classifications under the *Crown Land Plan*. A sensitivity analysis was carried out to examine the impact of allowing only a single harvest for some classifications and excluding some from harvesting all together. Land classifications under the *Crown Land Plan*, and the amount of timber harvesting land base within the classification (base case) are presented in Table 3.

Table 3. Classifications and the amount of timber harvesting land represented by the Crown Land Plan in the base case

Classification	Timber harvesting land base (hectares)
Agricultural development area	880
Aggregate management area	70
Community leases and licences	53
Community pasture area	4
Integrated forest management area	8 924
Important fish production stream	51
Natural environment area	875
Private land and other leases and licences	1 167
Recreation and conservation management area	207
Sand and gravel reserve	632
Settlement reserve area	893
Wildlife habitat emphasis	204
Wildlife habitat management area	586

5 Timber Supply Sensitivity Analyses

For the *Crown Land Plan* sensitivity analysis, land within the integrated forest management area was included in the timber harvesting land base. Land within the agriculture development area, aggregate management area and the sand and gravel reserve were excluded from the timber harvesting land base after the first harvest (1583 hectares) and all other areas were excluded from all harvest (4040 hectares). The impact of the Crown land plan sensitivity analysis is shown in Figure 21.

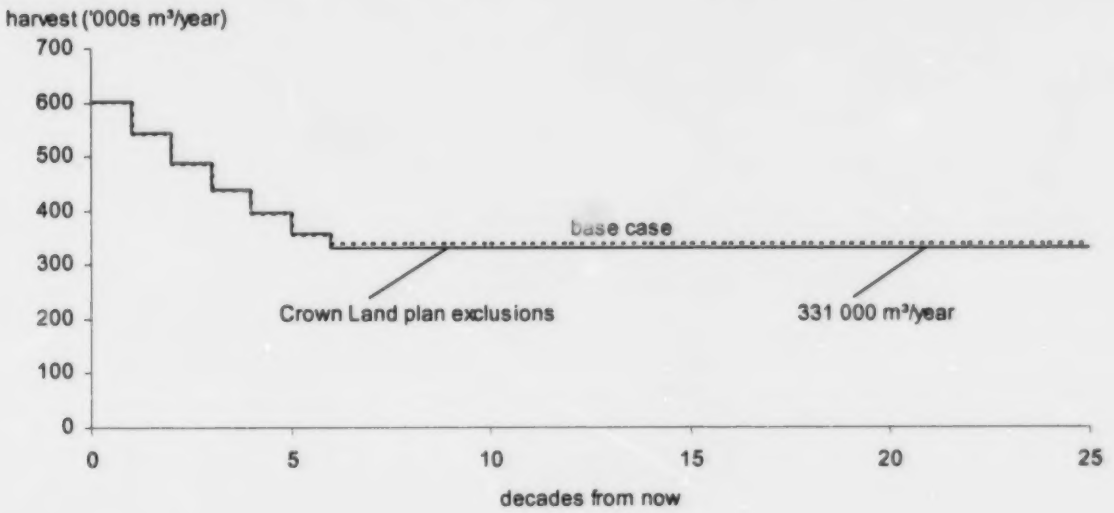

Figure 21. The effect of the crown land plan sensitivity — Robson Valley TSA, 2000.

The impact of excluding 4040 hectares of timber harvesting land within the Crown land plan and including only the first-pass harvest for an additional 1583 hectares was small, affecting the medium- and long-term harvest forecast. The harvest level in the long term is projected to be 9000 cubic metres per year lower than that of the base case (2.0% before and 2.6% after reductions for unsalvaged losses). The change in the long-term timber harvesting land base is also 2.6%.

5 Timber Supply Sensitivity Analyses

5.6 Impact of changing the amount of cedar-hemlock stands included in the timber harvesting land base.

In the Robson Valley TSA, the utilization of cedar and hemlock stands is sporadic in the wet interior cedar-hemlock subzone at the north end of the TSA, as they are only harvested when wood product prices are high. As a result , there is uncertainty about how many cedar-hemlock stands will be harvested and thus how many should be included in the timber harvesting land base.

Only wet subzone cedar-hemlock stands (timber supply blocks A, B, I, J) that could be logged using conventional logging equipment were included in the timber harvesting land base for the base case. Two sensitivity analyses were carried out: one including wet subzone cedar-hemlock stands, that are harvestable with all forms of logging equipment and the second removing all wet subzone cedar-hemlock stands from the timber harvesting land base.

The results of both sensitivity analyses are presented in Figure 22.

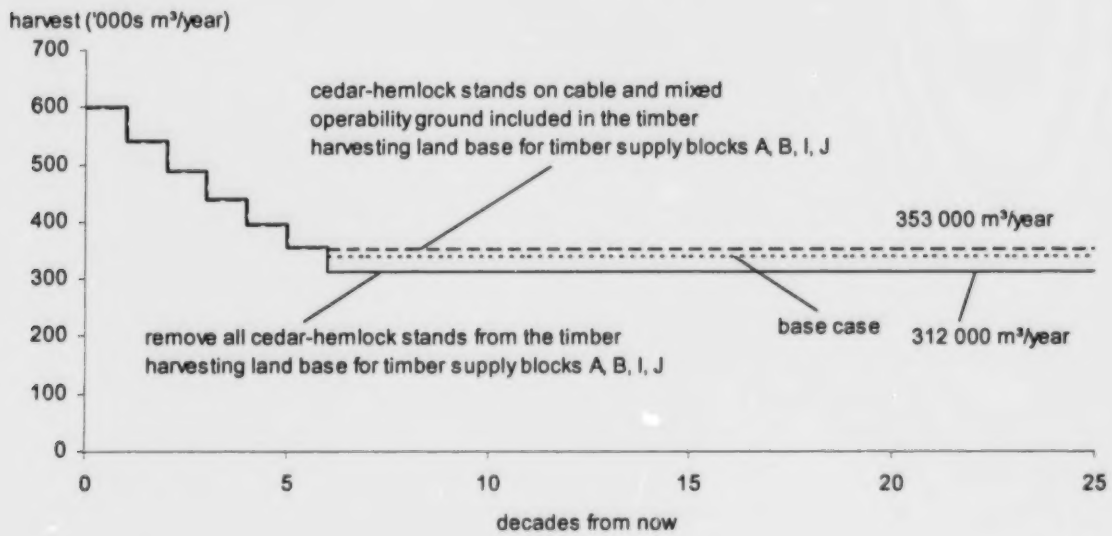

Figure 22. The effect on the harvest forecast of increasing and decreasing the amount of wet cedar-hemlock stands included in the timber harvesting land base — Robson Valley TSA, 2000.

Both the medium- and long-term timber supply are affected by the amount of wet subzone cedar-hemlock stands included. If all wet subzone cedar-hemlock stands are included, the timber harvesting land base increases by 2.6%, and the long-term harvesting level increases 13 000 cubic metres (3.0% before and 3.8% after reductions for unsalvaged losses) compared with the base case. If all wet subzone cedar-hemlock stands are removed from the timber harvesting land base, the long-term harvest level decreases 28 000 cubic metres (6.5% before and 8.2% after reductions for unsalvaged losses) relative to the base case. The timber harvesting land base decreases by 5.9%. The volume increase or decrease in the long-term harvest level is roughly proportional to the change in timber harvesting land base.

5.7 Impact of changing harvest scheduling priority

For the base case, the B.C. Forest Service timber supply model assigned harvest priority to all eligible stands based on the difference between the earliest age a stand can be harvested and its current age. A sensitivity analysis was carried out in which older stands were more randomly chosen for harvest, as Robson Valley Forest District staff felt this might better reflect operational harvesting patterns. For this sensitivity analysis, all lodgepole pine stands older than 100 years, and all other stands over 140 years, were randomly chosen for harvest if they were otherwise eligible for harvest (above minimum harvestable age and not restricted from harvest due to forest cover requirements).

Figure 23 shows that timber supply in the medium- and long-term is sensitive to a change to a more random harvesting pattern of older stands. With a more random harvesting pattern, younger stands that are still growing rapidly can be harvested before old stands which are growing more slowly, resulting in a volume loss. In the medium- and long-term the average harvest age resulting from a more random harvesting pattern is below the average age of maximum productivity.

The long-term harvest level is 40 000 cubic metres, or 12%, less than the base case harvest forecast.

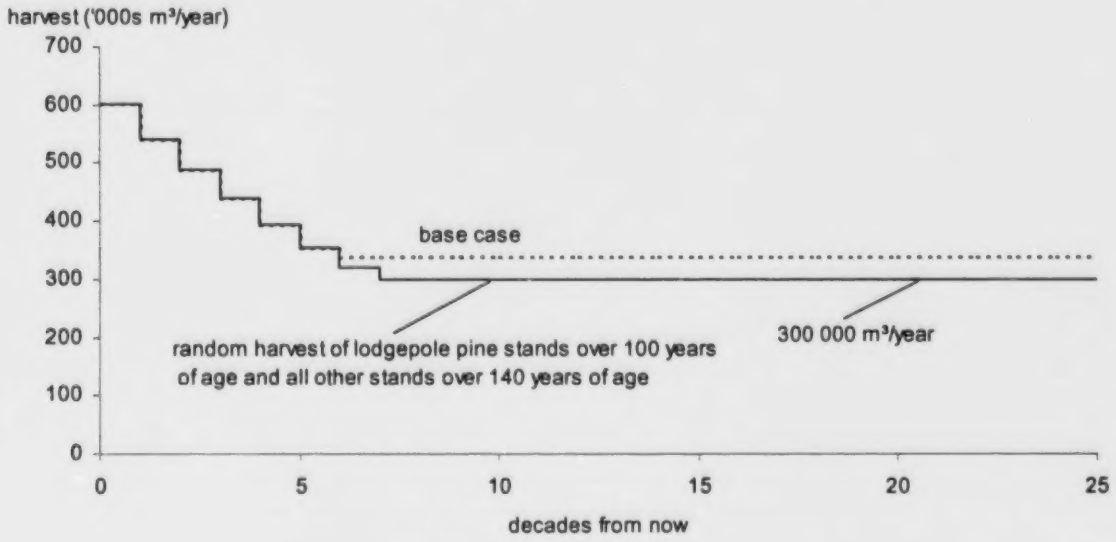

Figure 23. Harvest forecasts if stands harvested more randomly then in the base case — Robson Valley TSA, 2000.

5 Timber Supply Sensitivity Analyses

5.8 Uncertainty in the estimated existing stand yields

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory used to estimate timber volumes (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield. Although no specific issues were identified during the inventory audit of the Robson Valley TSA, a standard sensitivity analysis was performed. The results of decreasing and increasing existing unmanaged stand yield estimates by 10% are presented in Figure 24.

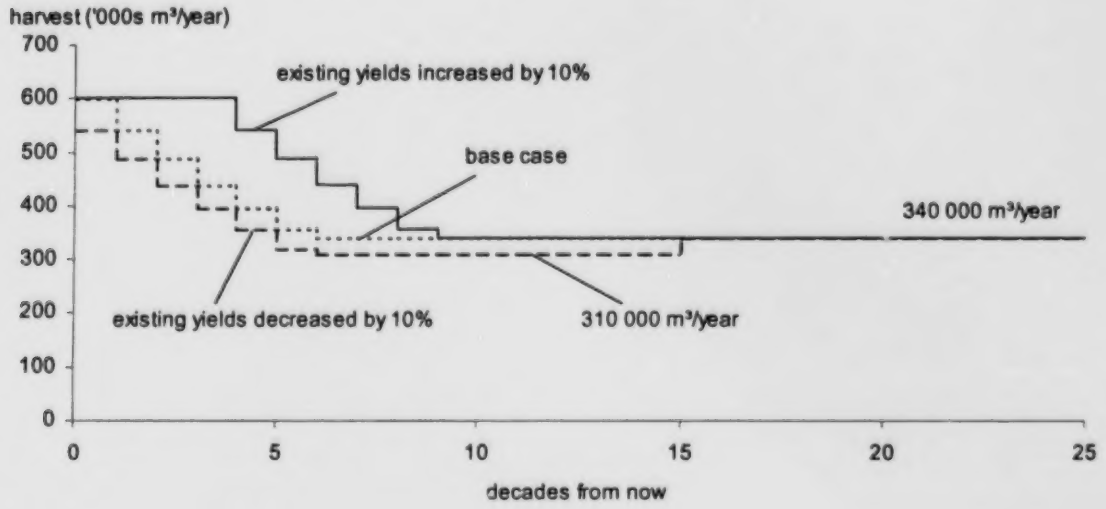

Figure 24. The effect on the harvest forecast of increasing and decreasing volume estimates for existing unmanaged stands by 10% — Robson Valley TSA, 2000.

Using harvest flow guidelines similar to those used to establish the base case, a decrease in existing stand volumes of 10% results in an initial harvest level of 548 370 cubic metres per year (10% lower than the current level). This harvest then declines to 310 000 cubic metres per year by the end of decade six before rising to the same long-term level as in the base case in decade sixteen. The long-term harvest level is the same as the base case since managed stand yields define the long-term level of harvest.

When existing unmanaged stand volumes are increased by 10%, the increased volume allows the current harvest level to be maintained for four decades before declining at 10% per decade. After decade nine the harvest level is the same as that obtained in the base case.

5 Timber Supply Sensitivity Analyses

5.9 Uncertainty in the estimated managed stand yields

Uncertainty in volume estimates for managed stands exists for the same reasons listed for existing stand yields (uncertainties in the forest inventory and the growth and yield models), but also because of the limited experience and data that is available for regenerated managed stands in B.C. There is also uncertainty around the site productivity assigned to older unmanaged stands relative to the site productivity expressed by the stands after they regenerate. This latter issue is examined in Section 5.10, "Uncertainty in the productivity of current old-growth sites after harvest."

As with existing unmanaged stand yield estimates, there are no specific issues directly related to managed stand yield estimation for the Robson Valley TSA. However, to assess the potential impact of general uncertainties in volume estimates for managed stands, a standard sensitivity analysis, in which managed stands yields were increased and decreased by 10%, was performed. The results are presented in Figure 25. When yields are decreased by 10%, the harvest forecast decreases by 42 260 cubic metres per year (9.8% before and 12.4% after non-recoverable losses) by the eighth decade and stays at this level for the remainder of the planning horizon. When yields are increased by 10% the long-term harvest level increases by 43 260 cubic metres per year (10.0% before and 12.7% after non-recoverable losses). Long-term harvest changes, before accounting for non-recoverable losses, are proportional to the change in managed stand yields.

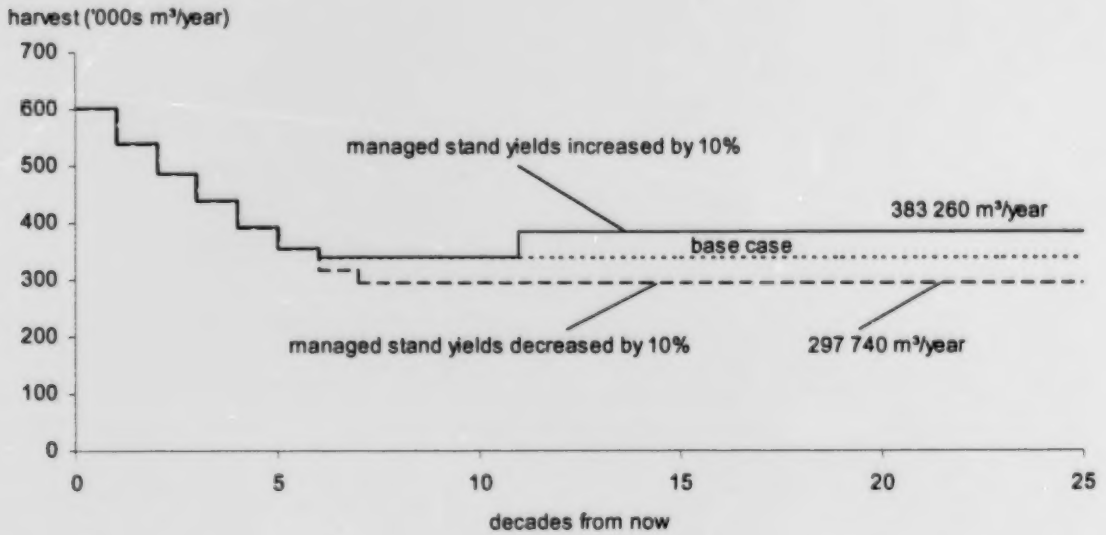

Figure 25. The effect on the harvest forecast of increasing and decreasing volume estimates for managed stands by 10% — Robson Valley TSA, 2000.

5.10 Uncertainty in the productivity of current old-growth sites after harvest

Estimating the future productivity of sites currently occupied by old-growth forest is difficult because they have never been regenerated and managed before. The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up age and the age at which stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old, that have existed long enough to demonstrate their productive potential, but have not yet experienced top breakage, dieback and disease associated old age, which also make productivity assessment difficult. The results of recent province-wide research suggest that the estimated productivity of sites currently occupied by old-growth stands may be significantly underestimated. Two Old Growth Site Index (OGSI) studies applicable to timber supply forecasting are:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in old-growth stands and adjacent logged and regenerated stands of the same productivity. Site index* was estimated for both and comparisons were made. Results are available for coastal Douglas-fir, lodgepole pine, and interior spruce.
- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study came from temporary and permanent growth and yield plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study.

The results of the aforementioned studies are of particular interest to the Robson Valley TSA, as stands older than 140 years comprise 58% of the timber harvesting land base. To test the sensitivity of the base case harvest forecast to uncertainty around site index estimates, site indices of these older stands were adjusted using either the paired-plot or veteran-tree results (paired plots were used where available as they are considered more accurate than veteran adjustments). Timber supply analysis inputs affected by changes in estimated future productivity (managed stand volume estimates, green-up ages and minimum harvestable age) were recalculated based on the adjusted site productivity estimates. Table 4 compares the average forest inventory-based site index for each old-growth analysis units to that defined using the OGSI adjustments. For a description of the analysis units see Appendix A, "Description of Data Inputs and Assumptions for Timber Supply Analysis."

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Table 4. Average analysis unit site index based on forest inventory and OGSI information — Robson Valley TSA, 2000.

Analysis unit	Species	BEC zone	Inventory site index	Adjusted site index
112	Sx	ESSF	17.4	20.8
122	Sx	ESSF	11.3	19.7
132	Sx	ESSF	7.4	18.9
212	Sx	ICH/SBS	19.3	21.2
222	Sx	ICH/SBS	13.2	20.0
232	Sx	ICH/SBS	8.7	19.2
322	Pl	ESSF	14.3	20.1
422	Pl	ICH/SBS	17.9	20.8
432	Pl	ICH/SBS	14.1	20.1
522	Fd	All	15.9	18.1
622	Bl	ESSF	10.6	14.9
632	Bl	ESSF	8.4	13.6
722	Bl	ICH/SBS	12.5	15.9
732	Bl	ICH/SBS	10.0	14.5
812	Cw	All	16.5	20.7
822	Cw	All	13.0	20.7
902	Hw	All	12.4	18.2
1112	Cw	ICH	16.3	20.7
1122	Cw	ICH	13.1	20.7
1212	Hw	ICH	14.0	18.9
1222	Hw	ICH	10.7	17.2

5 Timber Supply Sensitivity Analyses

Results of the OGSI sensitivity analysis are presented in Figure 26. The average site index for the entire Robson Valley TSA shifted from 13.4 metres to 17.4 metres after the OGSI adjustment. The graph shows that the harvest level can be maintained at 489 500 cubic metres per year from decade three onward as a result, impacting both the medium- and long-term. The long-term harvest forecast represents a 44% increase in harvest level over that of the base case. Site index adjustments are not included in the base case as there is little local data, and a lack of long-term monitoring data for regenerating stands to support the adjustments. The result of the sensitivity analysis, however, does provide some insight into the possible trends associated with site productivity estimates for the Robson Valley TSA and indicates that stand volumes may be higher than currently estimated for regenerated stands.

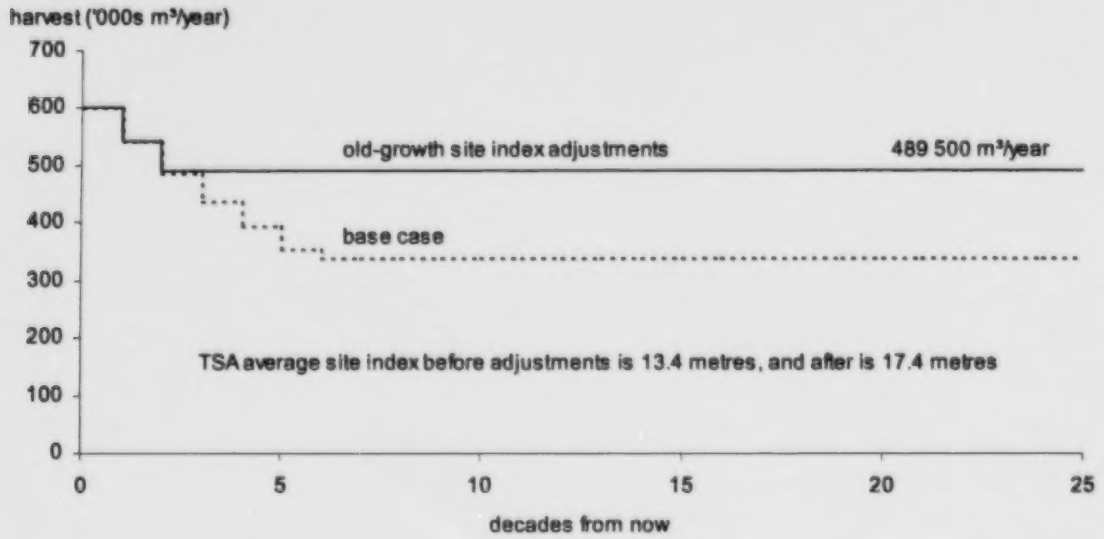

Figure 26. Harvest forecast based on OGSI (paired plot and veteran studies) site index adjustments — Robson Valley TSA, 2000

5.11 Uncertainty in the growth rate of seedlings from seed orchards

Reforestation following harvesting is required by law in British Columbia and reforesting with selected orchard seedlings (if available) is a requirement of the *Forest Practices Code*. For the past 40 years this province has been involved in a process of selecting and breeding trees with desirable traits such as faster growth, better stem and wood quality, and resistance to diseases and insect attack. Tree breeding offers potential gains in timber supply through increases in growth rate that may reduce minimum harvestable ages, increase volume at time of harvest, and ease of adjacency constraints through faster green-up. Seed selected as part of the tree breeding program can be obtained from seed orchards located throughout the province.

In this sensitivity analysis it was assumed that all planting of spruce stands from this day onward will employ seed obtained from seed orchards. A measure of the productivity gain associated with improved seed is called genetic worth. The genetic worth of improved spruce seed planted on average productivity sites in the Robson Valley TSA is 18%. This means that the volume of a spruce stand at an index age of 80 years, is expected to be 18% greater than from average seed collected from ecologically comparable areas. The percentage gain decreases after 80 years, and will also differ depending on site productivity. Figure 27 shows that the harvest level could increase by 5.9%, starting in decade seven, if reforestation in the Robson Valley TSA was accomplished using seed from the sources described above. This is lower than the 18% noted above as only about one-half the area is regenerated to spruce and actual harvest ages were seldom at age 80 years for spruce.

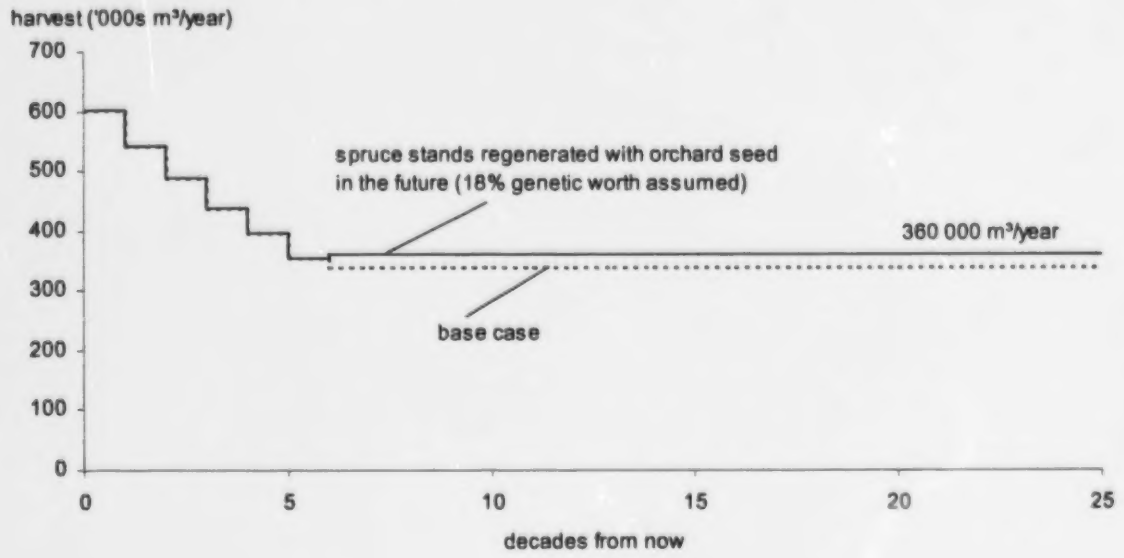

Figure 27. Harvest forecast if seeds from seed orchards were used for reforestation — Robson Valley TSA, 2000.

5.12 Uncertainty in the growth losses associated with spruce weevil

Spruce weevil causes damage to spruce-leading stands in the interior cedar-hemlock (ICH) and sub-boreal (SBS) spruce biogeoclimatic zones. For the base case, staff in the Robson Valley Forest District and Research Branch developed a yield adjustment for spruce-leading stands in the ICH and SBS subzones following regeneration. For the base case a 10% yield reduction was applied to managed spruce-leading stands to reflect the loss associated with weevil damage.

For this sensitivity analysis, the base case spruce weevil adjustments were increased and decreased by five percentage points to test for sensitivity to weevil losses. Figure 28 shows the impact of increasing and decreasing weevil damage losses.

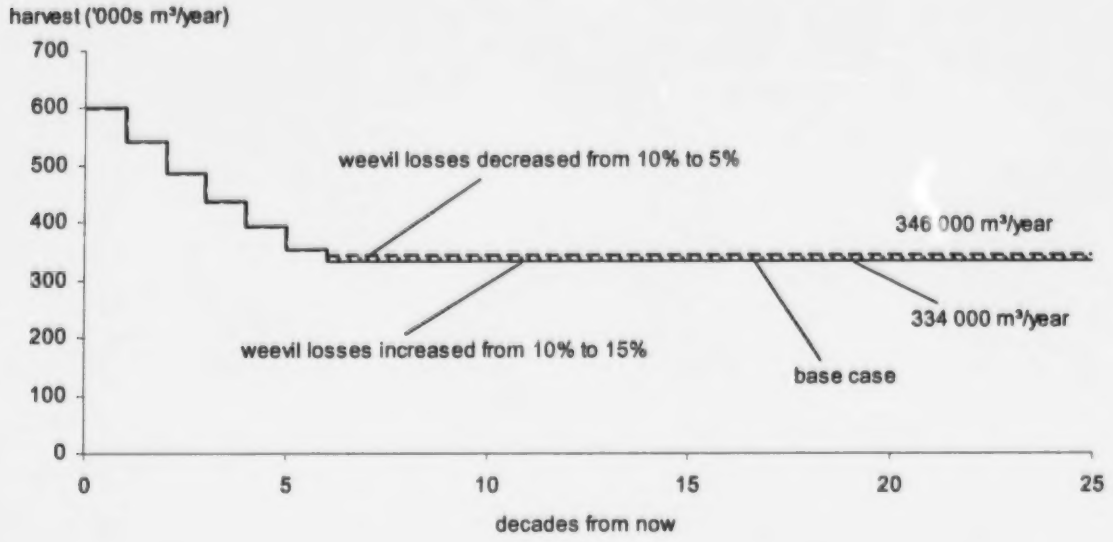

Figure 28. Harvest forecast if spruce weevil losses are increased and decreased — Robson Valley TSA, 2000.

The sensitivity analysis shows that the long-term harvest level is increased or decreased by 6000 cubic metres per year (2%) if weevil losses are increased or decreased by 5%. Spruce-leading stands represent about 46% of the timber harvesting land base and therefore the 5% change in regenerated stand yields on 46% of the land base results in a 2% change in long-term timber supply for the TSA as a whole.

5 Timber Supply Sensitivity Analyses

5.13 Uncertainty in estimated time to green-up

Forest cover requirements for visual quality, wildlife habitat, water quality and adjacency that are applied in this analysis involved estimates of when stands will reach a greened-up condition, which is expressed as a desired stand height. Green-up age, the age at which a stand exhibits the required height, was determined for the Robson Valley TSA from site productivity estimates and associated height/age relationships. The green-up period includes both the green-up age and the regeneration delay, or time taken to establish a stand after harvesting. Uncertainty about green-up period arises due to variation in regeneration delay and local stand growth when compared to the provincial height/age relationships.

Figure 29 shows that timber supply in the medium- and long-term is slightly sensitive to an decrease in the time to green-up age. If green-up ages were actually 5 years less than estimated for the base case, timber supply would increase to 345 000 cubic metres per year, or about 1% more than that of the base case. This small increase in harvest volume long term, is due to adjacent stands being available for harvest sooner.

Increasing green-up age had no impact relative to the base case.

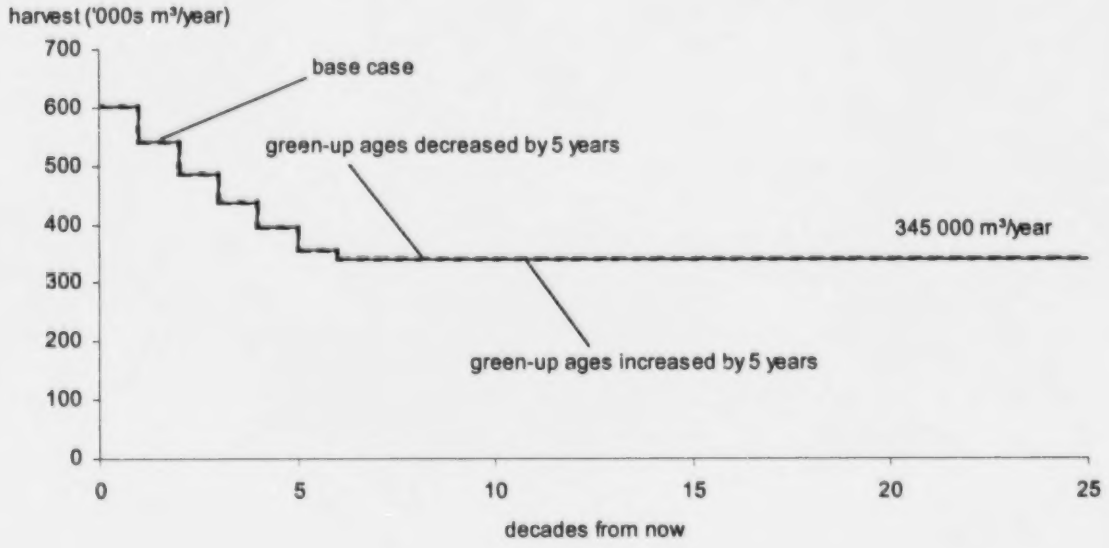

Figure 29. Harvest forecasts if green-up ages were either 5 years longer or shorter than in the base case — Robson Valley TSA, 2000.

5.14 Sensitivity to regeneration delay

The base case harvest forecast assumed it would take four years to re-establish stands following logging, and that on average the planting stock would be one year old. Some concerns were raised, during the public review of the data package, that actual regeneration delay may be longer than the 4 years used in the base case.

A sensitivity analysis was run with the regeneration delay increased by 5 years to 9 years. The impact of increasing the regeneration delay is that areas remain unproductive for a longer period after harvest, resulting in a growth loss. Minimum harvestable ages and green-up ages are also extended by the length of the regeneration delay.

Figure 30 shows that timber supply in the medium- and long-term is sensitive to an increase in regeneration delay. If the regeneration delay were actually 5 years longer than estimated in the base case, timber supply would decrease to 320 128 cubic metres per year, or about 6% less than that of the base case.

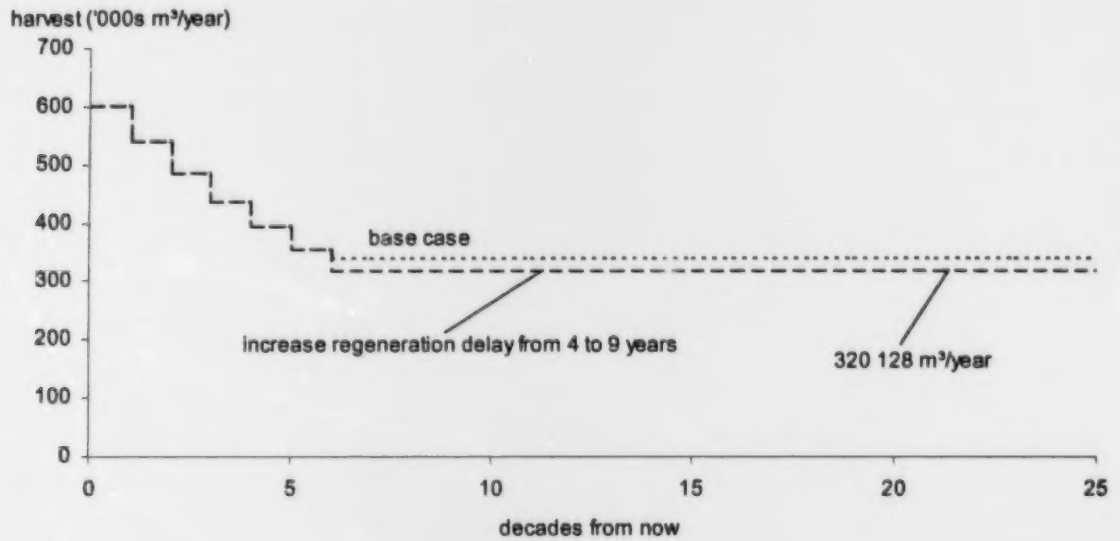

Figure 30. Harvest forecasts if regeneration delay were 5 years longer than in the base case — Robson Valley TSA, 2000.

5.15 Uncertainty in forest cover requirements for visual quality

Visual quality objectives have been established in the Robson Valley TSA to manage visually sensitive areas along Highways 5 and 16. The B.C. Forest Service, Forest Practices Branch, has provided a range of allowable visible disturbance for each visual quality objective, stated as maximum per cent area younger than visually effective green-up age.

Different disturbance limits are recommended for each visual quality objective (for example, partial retention) depending on the visual absorption capacity of the terrain and forest in the area. Table 5 shows the per cent allowable disturbances used in the base case and the upper and lower ends of the allowable disturbance range for each visual quality objective.

Table 5. Maximum allowable disturbance levels for various visual quality objectives— Robson Valley TSA, 2000.

	% allowable visible disturbance		
Visual quality objective	**Base case**	**Minimum disturbance sensitivity**	**Maximum disturbance sensitivity**
Preservation	1	0	1
Retention	3.5	1.1	5
Partial retention	10.5	5.1	15
Modification	20.5	15.1	25
Maximum modification	33	25.1	40

In the base case the allowable disturbance is generally in the middle of the disturbance range.

Uncertainty about forest cover objectives for visual quality may arise from inventory and classification of land into visual absorption capacity classes, from estimates of how well different disturbance limits may meet visual objectives, and from estimates of how non-harvestable forest may contribute to visual quality.

5 Timber Supply Sensitivity Analyses

Figure 31 shows the effect on timber supply if the allowable visual disturbance were at the minimum and maximum for all visual quality objectives in the Robson Valley TSA. If all visual quality objectives were held at the minimum allowable visible disturbance level, then timber supply would decrease to 300 000 cubic metres per year by decade eight and remain at this level. Long-term timber supply would be 12% lower than that of the base case.

If all visual quality objectives were held at the maximum allowable visible disturbance level, then timber supply could be maintained at about 356 000 cubic metres per year from the beginning of decade six onward. Long-term timber supply would be 4.9% greater than that of the base case.

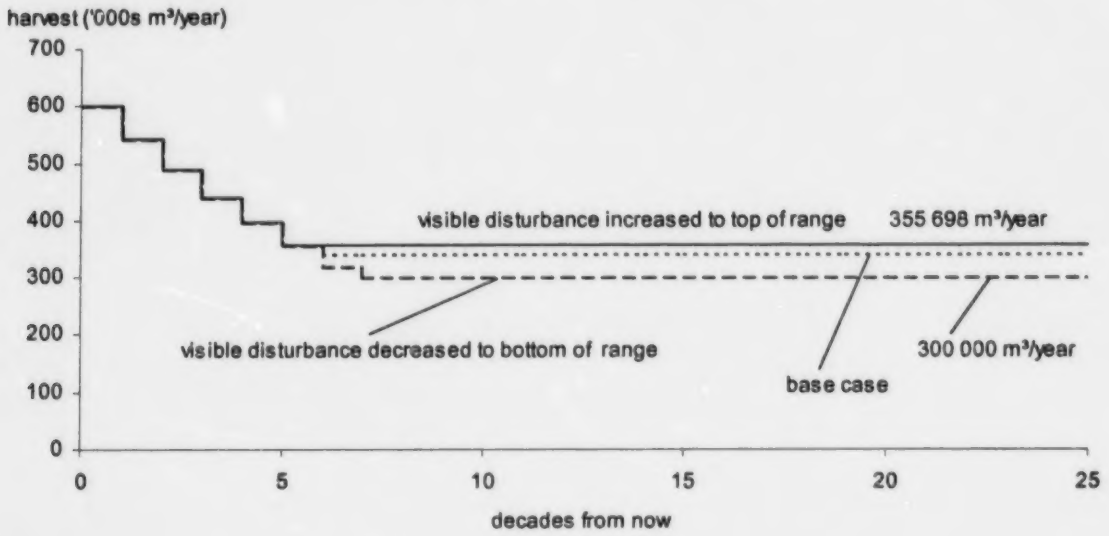

Figure 31. Timber supply projections if minimum and maximum allowable visible disturbance percentages were applied to all visual quality objectives — Robson Valley TSA, 2000.

In addition to the visual quality objective areas discussed above, other areas outside the Highway 5 and 16 corridors are considered scenic and have recommended visual quality classes. A second sensitivity analysis applied both the established visual quality objectives and recommended visual quality classes, with the allowable visible disturbance defined as in the base case. The timber harvesting land base area covered by visual quality requirements climbed from approximately 61 000 hectares (29%) in the base case to 150 000 hectares (70%) in this sensitivity analysis. Increasing the area under visual quality management had no effect on timber supply. Almost all the visual management area added in this sensitivity, is in the modification and maximum modification classes where allowable visual disturbance is highest. As a result, no sensitivity was shown to the additional forest cover requirements, although it should be noted that harvesting is projected to occur in more landscape units at any given time than in the base case. This may have operational implications if these additional visual quality classes are formally established as visual quality objectives.

5.16 Impact of partial harvesting to meet visual quality objective

In the base case, clearcut harvesting is assumed in all visually sensitive areas, with visual quality objectives being met by limiting the allowable visual disturbance. This analysis tests the impact of using partial harvesting in visually sensitive areas (simulated using forest cover requirements), to meet visual quality objectives rather than conventional forest cover constraints. The assumption in this analysis is that partial harvesting would leave stands in a visibly undisturbed state.

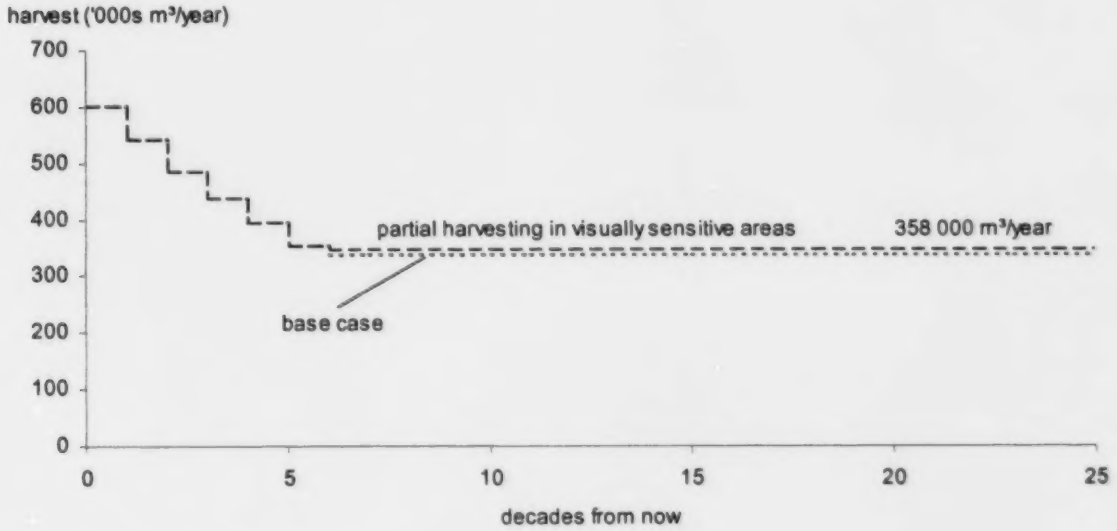

Figure 32. Timber supply projections if partial harvesting is used to meet VQOs rather than forest cover constraints— Robson Valley TSA, 2000.

This sensitivity analysis indicates that use of partial harvesting in visually sensitive areas could increase the medium- and long-term timber supply by 8000 cubic metres per year or 2.4% over that of the base case. The volume increase is largely due to harvesting stands more frequently, and optimally, in terms of volume growth in visual retention areas where the average harvest age drops from 380 years in the base case to 170 years in this sensitivity analysis. Partial harvesting does however require that more stands be accessed and disturbed every year than under a clearcutting regime with forest cover restrictions.

5.17 Uncertainty in the forest cover requirements for caribou habitat

Protection of caribou habitat was addressed in this analysis in two ways. Areas designated as high quality caribou habitat were removed from the timber harvesting land base. Management of areas designated as medium quality caribou habitat and caribou movement corridors was represented by forest cover requirements applied to control the maximum level of disturbance and the minimum amount of mature forest.

If the same forest cover requirements were applied to high quality caribou habitat as for medium quality habitat, that is, harvesting was permitted in high quality habitat, then the timber harvesting land base would increase by 20 204 hectares or 9.5%. The impact of including high quality caribou habitat areas in the timber harvesting land base was similar to the sensitivity analysis presented in Section 5.1, "Uncertainty in the estimated area of the timber harvesting land base," where the timber harvesting land base was increased by 10%. The current harvest level could be maintained for two decades before following a similar pattern as shown for the base case to the new long-term harvest level, 9.7% higher than that of the base case.

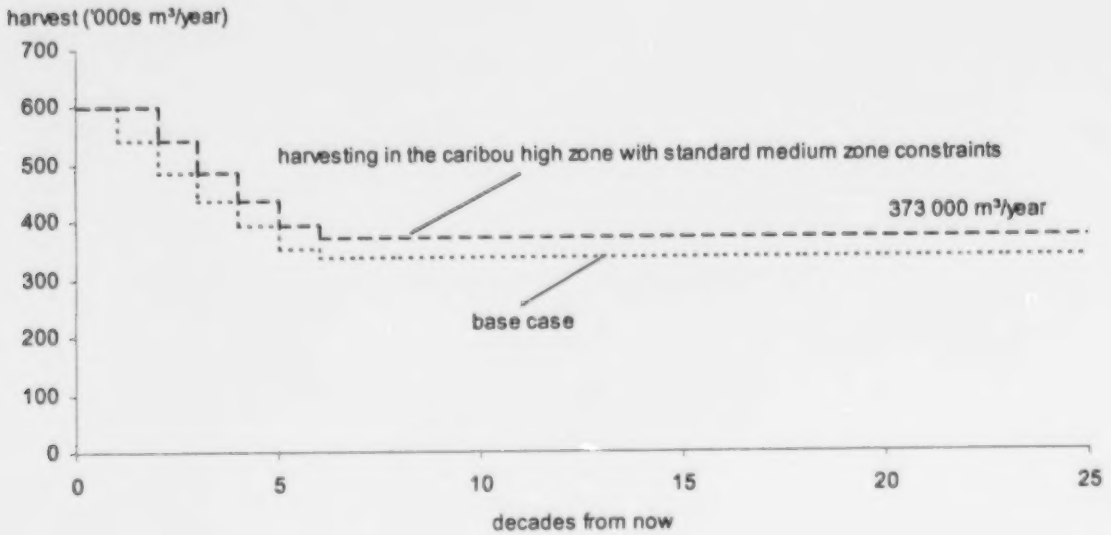

Figure 33. Harvest forecast if high quality caribou habitat had forest cover constraints applied, as for medium quality habitat, and harvesting is permitted — Robson Valley TSA, 2000.

A second sensitivity analysis assessed the impact of allowing harvesting in high quality caribou habitat under a more stringent set of forest cover constraints than used for moderate habitat. The modified forest cover requirements dictated that not more than 20% of the forest could be less then 80 years old, 66.7 % of the forest had to be over 150 years and 50% of the forest had to be over 250 years. This analysis yielded the same result as the previous sensitivity analysis, with the current harvest level being maintained for two decades before following a similar pattern as shown for the base case to the new long-term harvest level 9.7% above that in the base case.

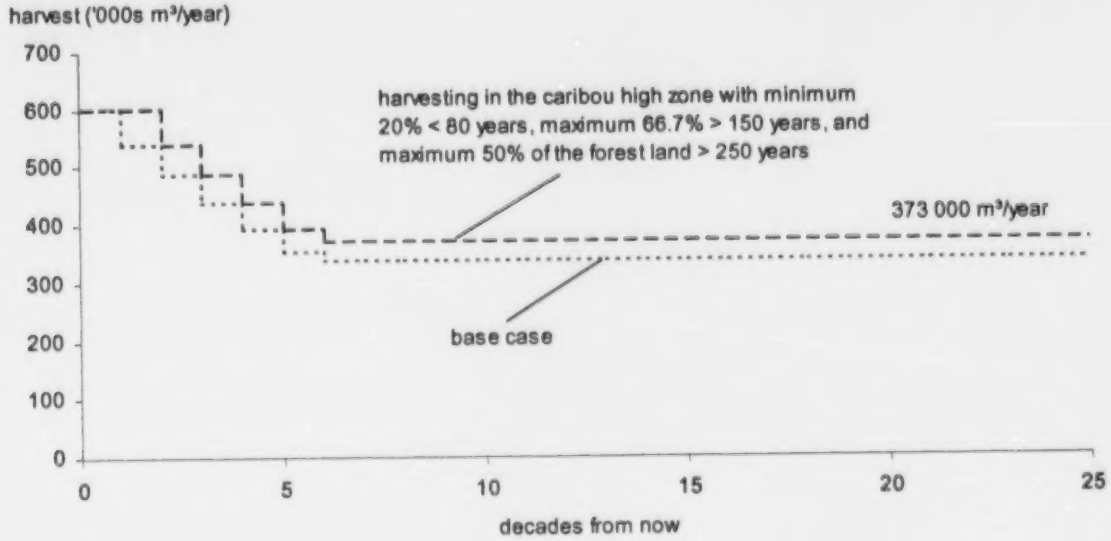

Figure 34. Harvest forecast if high quality caribou habitat has more stringent forest cover requirements than moderate habitat and harvesting is permitted — Robson Valley TSA, 2000.

The reason that the harvest forecast is similar with the more restrictive forest cover constraints, is because of the amount of high quality of caribou habitat that remains inoperable for this sensitivity analysis. The total area classified as high quality caribou habitat is 66 610 hectares but due to other land base definition criteria only 20 204 hectares is operable. This leaves 46 406 hectares of inoperable high quality caribou habitat to help meet forest cover requirements.

Other sensitivity analyses performed to test forest cover requirements for caribou include:

1) Running modified forest cover constraints for medium quality caribou habitat (not more then 20% of the forest less then 80 years, 66.7% of the forest over 150 years and 50% of the forest over 250 years).

2) Changing the minimum retention percentage for mature stands +/–10% for medium quality caribou habitat.

3) Changing the age when forests achieve "old" forest objectives by +/– 40 years.

None of these analyses showed an impact on the base case harvest forecast due to the large amount of inoperable land that contributes to meeting the forest cover constraints for medium quality caribou habitat.

5.18 Sensitivity analyses that had no impact on the base case timber supply

1) Uncertainty in volume reductions caused by root rot in regenerated Douglas-fir.

Armillaria ostoyae is a fungus which causes root disease and subsequent tree mortality in many tree species in British Columbia. Staff in the Robson Valley Forest District have noted the presence of *Armillaria* in Douglas-fir stands and have maps for areas at risk. In the base case, yields for Douglas-fir stands were reduced by approximately 5% on moderate *Armillaria* sites and 15% on severe sites to reflect expected mortality (see Table A-13. in Appendix A for details). For this sensitivity analysis, the base case *Armillaria* yield adjustments were increased by another five percentage points. The increased *Armillaria* impact had no impact on the base case harvest forecast as the area at risk
— 1119 hectares — (about 0.5%) is a small proportion of the total timber harvesting land base.

2) Application of Douglas-fir management guidelines for the Prince George Forest Region.

The Douglas-fir regional guidelines have two broad objectives. The first objective is that there will be no net loss of Douglas-fir forest types. The second objective is that stand structure and age class representation shall remain similar to the pre-harvest condition.

In the base case all stands are regenerated back to the species present at the time of logging, thus the first object is likely satisfied. In order to address the second broad objective, the age class structure of existing Douglas-fir stands was examined and forest cover requirements imposed to preserve this structure (7.1% of stands > 250 years, 32% of stands > 140 years and 72% of stands > 100 years of age). These forest cover requirements were applied in addition to all other forest cover requirements used in the base case. The additional forest cover requirements showed no impact relative to the base case harvest forecast as Douglas-fir stands only represent only 5% of the total timber harvesting land base.

3) Uncertainty in estimated minimum harvestable ages used in the base case.

Minimum harvestable age is an estimate of the time needed for a stand to reach a merchantable condition. Minimum harvestable ages determine when stands will be available for harvest, therefore affecting how quickly existing stands may be harvested. The time at which stands will become merchantable is highly uncertain. This is partly because of uncertainty about the growth of stands, but more importantly, because it is impossible to foresee future market conditions that will ultimately determine merchantability.

Minimum harvestable age is determined using yield curves and minimum stand volume criteria as described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." This method was chosen to ensure that only stands with sufficient merchantable volume would be considered available for harvest. Increasing and decreasing minimum harvestable ages by 10 years had no impact on the base case harvest forecast, indicating that the vast majority of stands are not harvested near the minimum harvestable age in the base case harvest forecast.

4) Sensitivity to forest cover requirements for the integrated resource management areas.

For the integrated resource management areas, the allowable disturbance, or area below green-up height, was reduced from 33% to 25% to see if the base case harvest forecast was affected. The base case harvest forecast was not impacted by the reduction in allowable disturbance.

A second sensitivity analysis was performed in which the allowable disturbance was further reduced to 20% for the integrated resource management areas. There was no short-term impact, but the base case harvest forecast could not be maintained in the long term with an allowable disturbance of 20% for the integrated resource management areas.

5) Uncertainty in the application of landscape-level biodiversity requirements.

As described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," prescriptions for maintaining biodiversity at both the stand level and the landscape level were modelled in the base case. Stand-level biodiversity was addressed in this analysis by removing portions of each stand from the timber harvesting land base. Potential effects of uncertainty about stand-level biodiversity can be assessed through sensitivity analyses that examine the timber supply impacts of land base reductions. Landscape-level biodiversity, however, was modelled in this analysis through the use of forest cover requirements applied to biogeoclimatic variants within each landscape unit.

Landscape units in the Robson Valley are still in draft form, and which landscape units will be assigned lower-, intermediate- or higher-biodiversity emphasis has yet to be established. The base case analysis was therefore run using a single weighted constraint for the retention of old-growth forests based on the anticipated distribution of 45% lower, 45% intermediate and 10% higher, biodiversity emphasis. The low emphasis portion the old-growth forest cover requirement, is phased in over a 210 year period.

A number of analyses were conducted to test the base case harvest forecast for sensitivity to management for landscape-level biodiversity. In no case was the base case timber supply affected. In the most stringent case, requirements for young, mature plus old and old forest all applied to draft landscape units based on corresponding biodiversity emphasis options, with the full old forest constraint being met immediately for low-emphasis landscape units. No sensitivity was shown to landscape-level biodiversity options due to the large amount of forest outside the timber harvesting land base that contributes to meeting biodiversity requirements.

6) Sensitivity to forest cover requirements for community watershed disturbance.

For watersheds, the allowable disturbance, or area below green-up height, was reduced from 5% to 0% in the first case and increased from 5% to 10% in a the second case to see if the base case harvest forecast was impacted. The base case harvest forecast was not impacted by the reduction or increase in allowable disturbance. This is due to the relatively small area in community watersheds — 2229 hectares or 1% of the timber harvesting land base — and contribution of 12 636 hectares of inoperable watershed area to the forest cover requirements.

7) Sensitivity to harvesting 45 000 cubic metres per year in the first decade from the Goat River landscape unit.

Robson Valley Forest District staff requested a sensitivity analysis be carried out in which 45 000 cubic metres of timber be harvested from the Goat River landscape unit per year for the first decade of the analysis horizon, consistent with the *Robson Valley Land and Resource Management Plan*. In the first decade of the base case harvest forecast, only about 10 000 cubic metres of timber is harvested per year in the Goat River Landscape unit.

The sensitivity analysis indicated that 45 000 cubic metres of timber could be harvested per year from the Goat River landscape unit in the first decade, while still meeting all other forest management objectives. However, no wood was harvested in the Goat River landscape unit in the following two decades.

6 Summary of Sensitivity Analysis Impacts

Table 6 summarizes all sensitivity analyses that showed an impact on the base case harvest forecast and when the impact occurred. Sensitivity analyses showing an increase relative to the base case harvest forecast are presented first, followed by those showing a decrease. Sensitivity analyses showing no impact relative to the base case are not included in Table 6 but listed in the footnote below the table.

Table 6. Summary of sensitivity analysis for the Robson Valley TSA.

Report section	Description	Impact of sensitivity analysis relative to the base case		
		Short term	Medium term	Long term
5.1	Land base increase 10%	+	+	+
5.2	Timber supply in protected areas	+	+	+
5.3	Decreasing ESA reductions		+	+
5.4	Decreasing mature stand volume exclusion threshold		+	+
5.6	Including more wet site cedar-hemlock		+	+
5.8	Increase existing stand yields 10%	+	+	None
5.9	Increase managed stand yields			+
5.10	Old-growth site index adjustments		+	+
5.11	Spruce established from improved orchard seed		+	+
5.12	Decreased weevil losses		+	+
5.13	Decreased time to green-up		+	+
5.15	Increased allowable visual disturbance		+	+
5.16	Partial harvesting in visually sensitive areas		+	+
5.17	Limited harvesting in high quality caribou habitat	+	+	+
5.1	Land base decrease 10%	–	–	–
5.3	Increasing ESA reductions		–	–
5.4	Increasing mature stand volume exclusion threshold		–	–
5.5	Impact of the Crown land plan		–	–
5.6	Excluding all wet site cedar-hemlock		–	–
5.7	Impact of random harvest priority		–	–
5.8	Decrease existing stand yields 10%	–	–	None
5.9	Decrease managed stand yields		–	–
5.12	Increased weevil losses		–	–
5.14	Increased regeneration delay		–	–
5.15	Decreased allowable visual disturbance		–	–

Note: Short term refers to the first 20 years of the harvest forecast, medium term is 21 to 100 years from now, and long term is after 100 years from now.

Sensitivities that had no impact on the base case timber supply (Report Section 5.18) include root rot, Douglas-fir guidelines, minimum harvestable ages, forest cover requirements for integrated resource management, landscape-unit biodiversity, watershed disturbance and harvest target for the Goat River landscape unit.

7 Summary and Conclusion of the Timber Supply Analysis

The results of this timber supply analysis suggest that the current allowable harvest level in the Robson Valley TSA of 602 377 cubic metres per year can be maintained for ten years without either requiring rapid and disruptive future harvest level reductions. Using current inventory and timber growth information and assuming continuation of current forest management practices, harvests could be maintained at the current level for ten years, if followed by a decline of 10% per decade for the following five decades. The harvest then remains at 340 000 cubic metres per year from decade seven onward.

The base case results described above reflect current knowledge and information on forest inventory, growth and management. However, uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses showed that these uncertainties affect timber supply to varying degrees, some having a positive impact and other a negative impact on timber supply.

Short-term timber supply is sensitive to changes which influence the amount of timber available from existing unmanaged stands, because the harvest forecast relies on harvests from these stands for the next 100 years. The uncertainties with the largest potential positive and negative effect on base case projected harvest levels over the short term (next 20 years) are estimates of timber volume in existing stands and the size of the timber harvesting land base. An audit conducted in 1998 showed that the inventory estimates of volume for mature stands (over 60 years old) are not statistically different from volumes derived using ground measurements. Overall, the audit therefore suggests that the inventory reasonably portrays the standing timber volume in existing stands at the TSA level.

There is no information to indicate that the base case timber harvesting land base is over or under-estimated. The base case timber harvesting land base excludes newly established protected areas. If it could be demonstrated that harvesting could occur in areas classified as high quality caribou habitat, without degrading this habitat, then the timber harvesting land base would increase relative to the base case, and the harvest forecast might improve in the short term.

Medium-term (21 to 100 years from now) timber supply is affected most significantly by changes to harvest priority (not harvesting oldest stands first), decreases in managed stand yields, changes to forest cover requirements for management of visual quality, adjustments to old-growth site index as well as the factors affecting short-term timber supply mentioned above. If stands are harvested more randomly than in the base case, the medium- and long-term harvest forecast is reduced significantly. If managed stand yields are 10% lower then predicted in the base case, the medium- and long-term harvest forecast is reduced. Visual quality guidelines apply to 29% of the timber harvesting land base and affect both the medium- and long-term timber supply. If the forest cover requirements in the visually sensitive areas were lower or higher than modelled, then medium- and long-term timber supply would be considerably different than shown for the base case. If site index is under-estimated in old-growth stands, as suggested by recent research, yields in the medium- and long-term could be significantly higher then in the base case harvest forecast.

Medium-term timber supply is affected to a lesser extent by changing environmentally sensitive area reductions, changing minimum volume thresholds for mature stand exclusions, changing the amount of wet subzone cedar-hemlock harvested, changing weevil loss estimates, increasing the amount of partial harvesting, planting improved orchard seed, reducing the time to green-up and increasing regeneration delay.

Long-term (over 100 years from now) timber supply is affected by uncertainties in all the above factors with the exception of changing existing stand yields.

A summary of sensitivity analyses that showed an impact relative to the base case is presented in Table 6. Approximately the same number of sensitivity analyses showed a positive impact relative to the base case harvest forecast as negative, with the majority affecting the medium- to long-term.

In conclusion, this analysis indicates that based on current inventory and growth and yield information, and the current management regime, timber harvests in the Robson Valley TSA can be maintained at the current level for the next ten years. The analysis indicates that several factors related to the current forest inventory and management regime could affect timber supply. However, with the exception of under-estimating site index estimates for old-growth stands, there is no conclusive evidence to suggest that significant inaccuracies exist in the information used in this analysis.

8 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the Timber Supply Review. The socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Robson Valley TSA with the level of activity that the TSA could support as the timber supply moves towards its long-term harvest level.

The socio-economic analysis examines harvest levels as projected in the base case harvest forecast and is not intended to examine alternative management scenarios.

The socio-economic analysis consists of the following:

1) a profile of the current socio-economic setting;
2) a description of the Robson Valley TSA forest industry; and,
3) an analysis of the socio-economic implications of the base case harvest forecast.

8.1 Current socio-economic setting

8.1.1 Current population and demographic trends

From 1991 to 1996, the population of the Robson Valley TSA increased by 12% to 4,081 people from 3,642. Since 1996, the population of the Robson Valley TSA has likely remained about the same. The largest communities in the Robson Valley TSA are Valemount and McBride with estimated 1999 populations of 1,362 and 757, respectively. Other communities in the TSA include Tete Jaune Cache, Croydon, Dunster, Crescent Spur, and Albreda.

Table 7. Robson Valley TSA and selected community population statistics, 1991–1999

	1991	1996	1999	Change 1991-1996 (%)	Change 1996-1999 (%)
McBride	596	770	757	29.2	–1.7
Valemount	1,159	1,357	1,362	17.1	0.4
Electoral area H[a]	1,934	2,038	N/A[b]	5.4	N/A
Robson Valley TSA	3,642	4,081	N/A	12.1	N/A
British Columbia	3,373,399	3,882,043	4,029,253	13.5	3.8

(a) Electoral area H includes the communities of Tete Jaune Cache, Croydon, Dunster, Crescent Spur, and other more rural communities within the Robson Valley TSA.

(b) Not applicable.

Source: Census of Canada 1991, 1996. Population projections from BC STATS Population Section.

8.1.2 Economic profile

From 1991 to 1996, the total experienced labour force in the Robson Valley TSA increased by 12.3% to 2,100 from 1,870.[1] In comparison, the provincial experienced labour force increased by 14% over the same period. The unemployment rate in the TSA dropped to 11.0% in 1996 from 13.0% in 1991. The current unemployment rate in the Cariboo Development Region, of which the Robson Valley TSA is a part, is 8.4%, down from 15.6% at the same time in 1999, and from an average 11.6% during all of 1999.[2] While these figures are not specifically for the Robson Valley TSA they do indicate the trend in the region's labour force.

The forest industry, including harvesting, silviculture, and wood products manufacturing, is the largest employer in the TSA. In 1996, the forest industry supported approximately 37% of the total labour force (see Figure 35). From 1991 to 1996, employment in the forest industry in the Robson Valley TSA increased by about 14%, mostly in the manufacturing sub-sector. Since 1996, employment in forest products manufacturing has returned to 1991 levels.

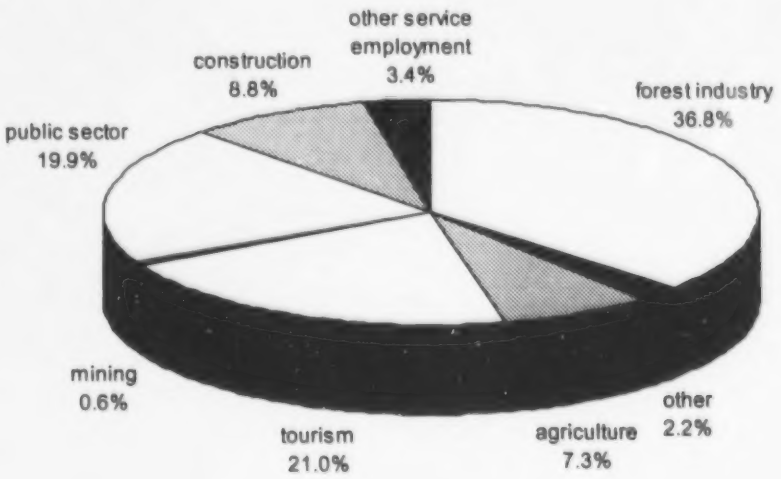

Figure 35. Robson Valley TSA total employment by sector, 1996.

Source: B.C. Ministry of Finance and Corporate Relations. 1999. The 1996 forest district tables.

The tourism and business travel sector is the second leading employer in the TSA and in 1996 supported approximately 21% of the total labour force. The Robson Valley is bestowed with some of the province's most scenic areas, including Mount Robson Provincial Park. The TSA has a high rate of traffic flow during the summer. Winter travel, especially for heli-skiing and snowmobiling, has increased in recent years also.

(1) Census of Canada 1991, 1996.

(2) Statistics Canada, Labour Force Survey.

The next largest employer is the public sector consisting of federal, provincial, regional, and municipal employees. In 1996, the public sector supported about 20% of the total labour force. While the tourism sector employed slightly more than the public sector, the public sector accounted for more than double the amount of income flowing into and within the TSA. Tourism-related employment income accounted for approximately 8% of the TSA's total income, while the public sector-related income accounted for 18%, indicating the higher incomes and spending in the public sector.

Employment multipliers illustrate this spending effect: a larger multiplier indicates how many extra, or spin-off, jobs a particular sector will support throughout the local economy. For example, the B.C. Ministry of Finance and Corporate Relations estimates that every 100 full-time direct forestry jobs in the Robson Valley TSA support an additional 39 indirect and induced jobs. In comparison, every 100 full-time direct jobs in the tourism sector support an estimated 12 indirect and induced jobs, and every 100 jobs in the public sector support an additional 24 indirect and induced jobs. The differences are a result of larger spending patterns by both forestry sector businesses and their employees, both of which tend to have higher revenues and incomes. Table 8 compares employment multipliers for sectors of the Robson Valley TSA economy.

Table 8. Sectoral comparison of employment multipliers, Robson Valley TSA

Basic sector	Employment multiplier
Forestry, logging, and manufacturing	1.39
Agriculture and food	1.18
Tourism	1.12
Public sector	1.24
Construction	1.37

Source: B.C. Ministry of Finance and Corporate Relations. 1999. The 1996 forest district tables.

8.2 Robson Valley TSA forest industry

8.2.1 Current allowable annual cut

The current (effective June, 1996) AAC for the Robson Valley TSA is 602 377 cubic metres, which includes 6000 cubic metres dedicated to deciduous species. Table 9 breaks down the AAC by tenure type. Before 1996, the AAC was 600 000 cubic metres and did not have a deciduous portion.

Table 9. Robson Valley TSA allowable annual cut, by licence type

	AAC (cubic metres)	Per cent (%) of AAC
Forest licences, replaceable	371 458	61.7
Timber sale licence (TSL) > 10 000 m^3	11 372	1.9
Timber sale licence < = 10 000 m^3	1 262	0.2
Small Business Forest Enterprise Program (SBFEP)	98 908	16.4
Forest Service Reserve	7 000	1.2
Woodlot licences	6 377	1.1
Forest licences, non-replaceable	100 000	16.6
Subtotal coniferous	596 377	99.0
Deciduous	6 000	1.0
Total Robson Valley TSA AAC	602 377	100.0

Source: B.C. Ministry of Forests.

8.2.2 Robson Valley TSA harvest history

Table 10 summarizes the volume of timber harvested in the Robson Valley TSA from 1995 to 1999. The actual volume of timber harvested is an important indicator of forestry activity in the TSA. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year indicates the level of economic activity. Differences in annual harvest levels are due to provisions for cut control[3], which allow licensees to vary their harvests based on operating and market conditions. If actual annual harvest levels are consistently less than the AAC, then forestry activity is below its full potential.[4]

In 1999, 358 127 cubic metres were harvested from the Robson Valley TSA (see Table 10). From 1995 to 1999, the annual average harvest was approximately 458 174 cubic metres. The main reasons for this shortfall in the harvest level are related to high delivered wood costs in the district, the recent poor markets for products, and low timber quality in some areas of the forest district. An increase in the price for the type of forest products produced in the Robson Valley TSA would help to reduce this undercut, but it is uncertain how high the price would have to be to overcome the high cost and poor quality issues. Other sources of timber from the Robson Valley forest district include woodlots and private lands. From 1995 to 1999, the average volume of timber from these two sources was 47 217 cubic metres per year. This average masks the annual differences, however, as volumes have steadily declined from a high of 68 975 cubic metres in 1995 to 27 879 cubic metres in 1999.

Table 10. Robson Valley TSA volumes billed, by licence type, 1995–1999.

Tenure	1995	1996	1997	1998	1999	Average 1995–1999
	(cubic metres)					
Forest licences	400 252	494 434	368 705	247 011	232 955	348 671
Small Business Forest Enterprise Program (SBFEP)	63 255	69 011	38 799	82 773	106 823	72 132
Timber sale licence (TSL)	7 562	10 476	6 410	10 801	2 881	7 626
Other[a]	12 594	29 021	54 589	37 052	15 468	29 745
Total	483 663	602 942	468 503	377 637	358 127	458 174
AAC	600 000	600 000	602 377[b]	602 377	602 377	

(a) Other consists of cutting permits such as rights of way, road permits, and other small temporary permits.

(b) The AAC increased to 602 377 in June, 1996.

Source: B.C. Ministry of Forests.

(3) Cut control allows licensees to vary the volume between annual harvest and AAC by +/– 50 % per year, and by +/– 10 % over a 5-year cut control period.

(4) Full potential referred to here is based on the allocated volumes of the AAC. It is not necessarily the same as full economic potential which is based on the international market for wood products.

8.2.3 Robson Valley TSA major licensees and processing facilities

Zeidler Forest Industries Ltd.

Zeidler Forest Industries Ltd. (Zeidler) has a replaceable forest licence in the Robson Valley TSA to harvest 186 428 cubic metres of timber per year, and a non-replaceable forest licence to harvest a further 50 000 cubic metres per year. The non-replaceable licence expires in November 2002. Table 11 outlines Zeidler's recent harvest activity and 1996 to 1998 average employment levels in person-years* of employment associated with its Robson Valley TSA operations.

Table 11. Zeidler volumes billed and provincial employment statistics

Allowable annual cut	
Forest Licence A15429	186 428 cubic metres
Forest Licence A40874	50 000 cubic metres
1999 volumes billed	106 080 cubic metres
1996-1998 average annual volumes billed	180 996 cubic metres
Employment[a] (1996-1998 person-years)	
Harvesting and administration	35
Road building and maintenance	5
Basic silviculture	18
Processing	150
Total	208

(a) The employment figures relate only to the 1996-1998 average volume of 180 996 m³ harvested from the Robson Valley TSA and processed in British Columbia.

Zeidler operations in the Robson Valley TSA include a veneer plant in McBride, which has an annual capacity to consume approximately 150 000 cubic metres of logs in the production 85 million square feet of veneer.[5] In 1998, this mill consumed about 130 000 cubic metres of timber to produce approximately 74 million square feet of veneer. Zeidler also operates a lumber mill in McBride with an annual capacity to process over 100 000 cubic metres of logs in the production of 22 million board feet of lumber. In 1998, this mill consumed about 53 000 cubic metres of timber to produce approximately 10 million board feet of lumber. Some 88% of the timber supplies for Zeidler's McBride operations come from the Robson Valley TSA, with the remainder coming from other areas such as Alberta.

Currently, Zeidler is for sale. How this may affect the operations of Zeidler is not reflected in Table 11or in the analysis of forest sector impacts that follows.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

(5) Lumber and veneer mill capacity is based on 490 eight-hour shifts per year.

Slocan Forest Products Ltd.

Slocan Forest Industries Ltd. (Slocan) has a replaceable forest licence in the Robson Valley TSA to harvest 175 018 cubic metres of timber per year, and a non-replaceable forest licence to harvest a further 50 000 cubic metres per year. The non-replaceable forest licence expires in November 2002. Table 12 outlines Slocan's recent harvest activity and 1996 to 1998 average employment levels in person-years of employment associated with its Robson Valley TSA operations.

Table 12. Slocan volumes billed and provincial employment statistics

Allowable annual cut	
Forest Licence A15430	175 018 cubic metres
Forest Licence A36096	50 000 cubic metres
1999 volumes billed	140 252 cubic metres
1996-1998 average annual volumes billed	186 959 cubic metres
Employment[a] (1996-1998 person-years)	
Harvesting and administration	60
Road building and maintenance	6
Basic silviculture	16
Processing	81
Total	163

(a) The employment figures relate only to the 1996-1998 average volume of 186 959 m^3 harvested from the Robson Valley TSA and processed in British Columbia.

Slocan's lumber mill in Valemount has an annual capacity to produce close to 100 million board feet of lumber, which would require about 350 000 cubic metres of timber. In 1998, the Valemount mill consumed approximately 226 000 cubic metres of timber in the production of approximately 56 million board feet of lumber. Close to 80% of the timber processed at the Valemount mill comes from the Robson Valley TSA.

Other licensees and processing facilities

Hauer Bros. Lumber Ltd. (Hauer Bros.) is the third largest operator in the TSA and operates a lumber mill in Tete Jaune Cache. Hauer Bros. has a timber sale licence to harvest 11 372 cubic metres per year. Under their timber sale licence, Hauer Bros. harvested an average of about 9900 cubic metres per year between 1996 and 1998. The Tete Jaune Cache lumber mill has the capacity to consume approximately 75 000 cubic metres per year in the production of 16.8 million board feet of lumber. From 1996 to 1998, the average volume processed at the Hauer Bros. mill was about 22 000 cubic metres.

Another licensee in the Robson Valley TSA is Bell Pole Co. Ltd. (Bell Pole) with a replaceable forest licence to harvest 11 112 cubic metres per year. Bell Pole uses or trades its volume for the appropriate species and size for making poles. In 1996 and 1998, Bell Pole harvested approximately 3600 cubic metres of timber from its Robson Valley TSA licence. However, in 1997 the company did not harvest any timber under this licence. Bell Pole operates four pole mills within the province at Lumby, Maple Ridge, Revelstoke, and Terrace. In 1998, these mills had a combined total input of 72 000 cubic metres.

Numerous other small processors are located in the Robson Valley TSA, all employing fewer than 10 people. The largest of these include Marsh Bros. Lumber and Supply Ltd., Lobo Log Crafters, Cedar Three Ltd., and Canoe River Wood Products. Other smaller operators generally working year round include Ski Lumber, TRC Cedar, Corwood Timber Products Ltd., and Gibbs Custom Sawmill. These mills produce a range of products such as custom cut lumber, pallet stock, posts and rails, log homes, shake and shingles, and firewood. These mills are in operation for most of the year and in total process approximately 40 000 cubic metres per year and employ about 40 people. The timber supply for these smaller mills comes from the TSA's SBFEP, other forest districts, and private sources. Numerous other smaller processors operate within the TSA, generally on an intermittent or seasonal basis, and employ another 40 people on a part-time basis.

From 1996 to 1998, an average of 87% of the timber harvested in the TSA was scaled and processed or traded within the TSA. A further 4% per year was shipped to the Prince George Forest District and approximately 3% was shipped to the Revelstoke and Kamloops Forest Districts. Other smaller volumes went to the Salmon Arm, Columbia, and Vernon Forest Districts.

8.2.4 Forest sector employment and employment coefficients

The preceding harvesting and employment information is used to develop employment coefficients, which are used to project future employment levels within the forestry sector. For this purpose, the forestry sector has been divided into three sub-sectors:

- harvesting and other woodlands-related employment including falling, log transport, log salvage, log scaling, harvest planning, and administration;
- silviculture employment such as planting, surveying, and other basic and intensive silviculture activities, such as spacing, fertilization, and pruning*; and,
- primary timber processing employment at lumber mills, veneer, and plywood mills, shake and shingle mills, chip mills, log home mills, and pulp and paper mills.

Harvesting and silviculture employment

The harvesting component of the forest industry is the most closely tied to the AAC and includes both company and contract loggers. Clearcutting, using cable, skidder, and on steeper slopes, helicopter yarding systems, is the predominant silvicultural system used in the Robson Valley TSA. The active logging season varies depending on company and terrain, but can continue throughout the year.

Silviculture is perhaps the least tied to the current level of harvest, given that silviculture activities continue for 10 to 15 years following harvesting. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting, and some spacing. Enhanced, or intensive, silviculture includes spacing, fertilization, and pruning. In the TSA, licensees are responsible for basic silviculture on areas harvested under major licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land, and uses silviculture contractors to complete this work.

Data compiled for this Timber Supply Review indicate that from 1996 to 1998, the average TSA harvest of approximately 483 027 cubic metres supported approximately 171 person-years of direct harvesting and silviculture employment across the province. Robson Valley residents account for about 78% of this employment.

Pruning
The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Processing employment

About 87% of the timber harvested in the Robson Valley TSA remains in the TSA for processing into lumber, veneer, and other products. Residual chips from milling operations generally flow to Prince George or Kamloops for processing into pulp. Data compiled for this Timber Supply Review indicate that from 1996 to 1998, the TSA harvest of approximately 483 027 cubic metres supported approximately 315 person-years of direct processing employment across the province.

Forest Service employment

The Robson Valley TSA is administered by the Robson Valley Forest District office in McBride. Currently, 29 people work in the forest district office. Forest Service staff are involved in the administration and enforcement of government policy for the TSA, and planning related to the Small Business Forest Enterprise Program.

Robson Valley TSA employment coefficients

Table 13 summarizes the employment supported by the 1996-1998 average harvest in the Robson Valley TSA and the corresponding employment coefficients. These coefficients have been calculated at TSA and provincial levels to highlight the importance of the forestry sector within the Robson Valley TSA and to identify the contribution that the Robson Valley TSA's forestry sector makes to the provincial economy. The two employment levels are defined as follows:

1) TSA employment and employment coefficients, which comprise residents of the Robson Valley TSA who are employed in the forestry sector within the Robson Valley TSA and who rely on the Robson Valley TSA timber supply; and,

2) provincial employment and employment coefficients, which comprise all forestry sector employment in the province that relies on the Robson Valley timber supply, including both residents of the Robson Valley TSA and those who live elsewhere.

Employment is divided into direct, indirect, and induced components; the sum of the components is the total impact. The coefficients are expressed as the number of full-time jobs, or person-years, per 1000 cubic metres of timber harvested. Indirect and induced employment figures were derived using employment multipliers developed by the B.C. Ministry of Finance and Corporate Relations.

For more detailed information regarding employment coefficients see Appendix B, "Socio-Economic Analysis Background Information."

Table 13. Robson Valley TSA employment and employment coefficients[6], average 1996–1998

Forest industry activity	TSA employment (person-years)	TSA coefficients (person-years / '000s m³)	Provincial employment (person-years)	Provincial coefficients (person-years / '000s m³)
Harvesting	125	0.26	125	0.26
Silviculture	8	0.02	46	0.09
Processing	213	0.44	315	0.65
Total direct	346	0.71	485	1.00
Indirect + induced	135	0.28	590	1.22
Total employment	481	0.99	1,075	2.22

Note: Employment estimates are reported in person-years based on average 1996–1998 employment levels and the average 1996–1998 Robson Valley TSA harvest of 483 027 cubic metres.

(6) Other employment coefficients may be found in other documents for the same or similar areas. A difference in ratios can occur for several reasons, such as using different sources of employment data and rounding of estimates, dividing employment by a different harvest level, using a different definition of a full-time position and changing the definition of forestry sub-sectors. However, the size of impacts associated with a timber supply change should be the same.

8.2.5 Robson Valley TSA employment income

In 1998, the average income for forest sector employees in the Robson Valley TSA was approximately $46,390 per year, based on average provincial income levels for logging and forestry services, solid wood manufacturing, and pulp and paper manufacturing[7] (see Appendix B, "Socio-Economic Analysis Background Information"). Average income for indirect and induced sector employees was $34,070 per year. The total direct income associated with the forest sector in the Robson Valley TSA averaged $22.5 million per year and total income for indirect and induced employment averaged $20.1 million per year (incomes are reported in 1998 dollar values). Combined, total employment income associated with the Robson Valley TSA harvest averaged $42.6 million per year. Table 14 shows average annual wages and salaries, total income levels, and total income per 1000 cubic metres.

Table 14. Average direct and indirect/induced incomes and total employment income, 1996–1998

	Average wage ($1998 value)	Total income ($ millions)	Total income ($/'000s m³)
Direct	46,390	22.5	46,580
Indirect + induced	34,070	20.1	41,610
Total income		42.6	88,190

8.2.6 Provincial government revenues

The provincial government receives various taxes and other revenues from the forest industry. The forest industry pays stumpage, royalties, and rents to the provincial government for the rights to timber and its use, and other industry operating taxes such as corporate income, property and sales taxes. The provincial and federal governments also receive revenues from forestry employees through income taxes.

In 1998, forest industry activity in the Robson Valley TSA led to approximately $8.6 million in stumpage and rent payments to the provincial government. Other government revenues from the forest industry accounted for $4.4 million and total employment supported by the Robson Valley TSA harvest contributed total provincial and federal income taxes worth $11.1 million. About one-third of the income tax, or $3.7 million, goes to the provincial government. Table 15 shows average government revenues for 1996 to 1998.

Table 15. Average provincial government revenues, 1996–1998

	Average revenue 1996–1998 ($1998 millions)	Revenue ($/'000s m³)
Stumpage, rents, and royalties	8.6	17,800
Industry taxes	4.4	9,037
Provincial income tax	3.7	7,660
Total government revenues	16.7	34,500

Due to rounding, column totals may not be consistent with corresponding rows.

(7) Although no pulp mills are located within the Robson Valley TSA, pulp logs and residual wood chips flow to pulp mills located outside the TSA. Consequently, the Robson Valley TSA does support pulp mill jobs within the province.

8 Socio-Economic Analysis

8.3 Socio-economic implications of the base case harvest forecast

The socio-economic analysis focuses on harvest level changes in the short- to medium-term of 10 to 30 years from now and considers:

- the implications of alternative harvest levels for both the Robson Valley TSA and the province;
- possible impacts on communities within the TSA;
- timber requirements of processing facilities within the Robson Valley TSA; and,
- regional timber supply implications.

The socio-economic analysis considers average levels of forest industry related activity that the base case harvest forecast could support. Impacts associated with future harvest levels are calculated using employment, income, and revenue coefficients (per 1000 cubic metres). This method assumes that the current role of the forest industry in the provincial economy continues and that labour productivity will not change. This means that, for example, employment levels in the future can be predicted based on today's relationship between employment and the volume of timber harvested and processed. The analysis also assumes that the proportions of harvesting, silviculture, and timber processing employment will remain constant and that the types and proportions of wood products manufactured will remain the same.

While this method is reasonably accurate for short-term forecasts (within the next five years), employment coefficients 20 years from now may be very different due to changes in market conditions, timber processing technologies, etc. The analysis indicates the size of impacts to employment, employment income, and provincial government revenues, within a constantly changing socio-economic environment.

8.3.1 Short- and long-term implications of alternative harvest levels

Robson Valley TSA employment and income impacts focus on those workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as is employment supported by timber that is harvested within the Robson Valley TSA, but is processed at mills outside the TSA. Table 16 indicates the employment and income that the current AAC can support when fully harvested and processed, and the levels that would be supported in the short to medium term by the harvest volumes suggested in the base case forecast.

The current AAC of 602 377 cubic metres, if fully harvested, can support about 428 person-years of direct employment and a further 167 person-years of indirect and induced employment within the TSA. As Table 16 indicates, however, the average TSA harvest has been below the AAC and forest industry activity has been at approximately 80% of its maximum level. The AAC for the Robson Valley TSA can provide about $25.6 million in annual total employment income within the TSA.

The first decade of the base case has no reductions in the timber supply relative to the current AAC. In the second and third decades, however, the timber supply is forecast to decline by 10% in each decade. Direct employment in the TSA could decline by 43 person-years in decade two and a further 38 person-years in decade three. Indirect and induced employment could decline by 17 person-years in decade two and a further 15 person-years in decade three. Given that the harvest in the TSA has been below the AAC for four of the last five years, these timber supply reductions may not affect the existing labour force if the industry has already adjusted its employment to match the recent harvest levels. These projected reductions do, however, limit the potential employment that could be supported if the timber supply were fully used.

Provincial employment and income impacts

Provincial employment and income impacts include all the activity supported by the Robson Valley TSA harvest, regardless of processing location and place of residence.

The current AAC of 602 377 million cubic metres can support approximately 600 person-years of direct employment and a further 730 person-years of indirect and induced person-years across the province. This level of employment results in $52.8 million in annual total employment income across the province.

In decade two, the reduction in the timber supply could lower the potential direct employment that the Robson Valley TSA could support by about 60 person-years, and in decade three by a further 54 person-years. The reduction in the timber supply could lead to a reduction of 73 person-years of indirect and induced employment in decade two and a further 66 person-years of indirect and induced employment in decade three. These changes in employment could occur across the province in areas that rely on Robson Valley TSA timber and where supply and service businesses cater to companies in the Robson Valley TSA. As stated, recent harvest levels indicate that a minor reduction in the Robson Valley TSA alone may not affect local forestry operations. However, cumulative effects associated with potential reductions in the Robson Valley TSA and other areas of the province could negatively impact the province's forest industry sector.

Table 16. Robson Valley TSA socio-economic impacts: base case harvest forecast

		Base case harvest forecast		
	At current[a] AAC	Decade 1	Decade 2	Decade 3
Timber supply ('000s m³)	602 377	602 377	542 139	487 925
Harvest level (1996–1998 average)	483 027	N/A	N/A	N/A
Difference from current AAC	119 350	0	– 60 238	– 114 452
Robson Valley Timber Supply Area				
Employment		(person-years)		
Direct	428	428	385	347
Indirect + induced	167	167	150	135
Total	595	595	536	482
Range[b] of employment gain (loss)		0	(54 – 59)	(102 – 113)
Employment income		($1998 millions per year)		
Direct	19.9	19.9	17.9	16.1
Indirect + induced	5.7	5.7	5.1	4.6
Total	25.6	25.6	23.0	20.7
Range of income gain (loss)		0	(2.3 – 2.6)	(4.4 – 4.9)
Province[c]				
Employment		(person-years)		
Direct	601	601	541	487
Indirect + induced	731	731	658	592
Total	1,331	1,331	1,198	1,078
Range of employment gain (loss)		0	(116 – 133)	(220 – 253)
Employment income		($1998 millions per year)		
Direct	27.9	27.9	25.1	22.6
Indirect + induced	24.9	24.9	22.4	20.2
Total	52.8	52.8	47.5	42.7
Range of income gain (loss)		0	(4.6 – 5.3)	(8.8 – 10.1)
Provincial government revenues		($1998 millions per year)		
Stumpage and related payments	9.8	9.8	8.8	7.9
Forest industry taxes	5.4	5.4	4.9	4.4
Employee income taxes	4.6	4.6	4.1	3.7
Total	19.8	19.8	17.8	16.0
Gain (reduction) in revenues		0	(2.0)	(3.8)

(a) Estimates for current employment in Table 16 differ from those in Table 13. Employment figures Table 16 are based on the current AAC of 602 377 cubic metres, while the figures in Table 13 are based on the 1996-1998 annual average harvest volume of 483 027 cubic metres. Due to rounding, some totals may not be the sum of their components.

(b) The ranges for employment and income changes are cumulative and account for employment insurance and other social assistance programs that provide temporary short-term income to unemployed or displaced workers. The range's upper limit assumes that all those who are unemployed or displaced leave the TSA to seek opportunities elsewhere and no longer spend any income locally, thus imparting a higher impact on the local economy than if they had not left. The range's lower limit assumes that employment insurance and other social assistance payments temporarily encourage unemployed or displaced workers to stay in the community. They will continue to spend some income locally and lessen the induced impacts of a lower harvest level. The actual impacts of changes in harvest levels on employment and incomes will likely fall within the specified ranges. See Appendix B, "Socio-Economic Analysis Background Information" for more details.

(c) TSA employment and income estimates are included as part of the provincial employment and income estimates.

N/A: not applicable.

Government revenue impacts

Provincial government revenues from the forest industry include stumpage, royalties, and rent payments; other taxes such as logging, corporate income, sales, property, and electricity taxes; and income taxes from direct, indirect, and induced employees. Under the existing tax and stumpage regimes, the current AAC of 602 377 cubic metres if fully harvested would provide on average approximately $19.8 million annually to the provincial government.

During the first decade, provincial government revenues will remain much the same, assuming tax, stumpage, royalty, and rent rates are similar to the average rates from 1996 to 1998. In decades two and three, government revenues associated with the Robson Valley TSA timber supply could decline by about $2 million in each decade.

8.3.2 Community level impacts

The impacts of short- and long-term changes in the timber supply may affect the socio-economic environment of a community. A reduction in employment and income related to a change in the timber supply may affect various socio-economic conditions in communities. These conditions include population growth rates; the size of the labour force; economic development opportunities; and federally, provincially, and locally funded services. These changes would have a greater effect on an economy dependent on a single industry than on one which is more diversified.

The timber supply in the Robson Valley TSA is stable in the short term, but could be about 20% lower by the third decade of the forecast. This drop is equivalent to a reduction in the annual timber supply of close to 115 000 cubic metres of timber. Employment in the forest sector has declined from 1996 to 1999, although population levels have increased. This trend indicates the TSA is growing and attracting new residents, which may be due to an expanding tourism industry. However, this overall picture does not reflect changes in the forestry sector, and related community level changes and individual impacts that have been occurring. Further, the loss of forest industry related income would not be replaced by an equivalent number of tourism workers, for example. Nonetheless, communities should seize development opportunities where possible.

8.3.3 Nature, production capabilities, and timber requirements of processing facilities

The total processing capacity of the Robson Valley TSA is about 750 000 cubic metres of timber. However, from 1996 to 1998, the average total volume processed per year was 550 000 cubic metres, approximately 25% below capacity. Not all mills operated below capacity in each of the years; however, the data indicate that the TSA does have excess milling capacity. The community has voiced some concern over timber leaving the TSA for processing in other forest districts.

To operate at full capacity, TSA mills require timber from other forest districts or provinces (for example Alberta). The reductions in Robson Valley TSA timber supply forecast in decades two and three would be expected to put additional pressures on local milling operations that are currently unable meet their capacity requirements.

8.3.4 Regional timber supply issues

The Robson Valley TSA lies between northern British Columbia, which has more stable timber supplies, and southern British Columbia, which has a longer history of harvesting activity and a less stable supply. Based on timber supply forecasts for the Timber Supply Reviews, timber supplies in northern British Columbia are stable or increasing. However, the timber supply forecasts for some management units in the Nelson and Kamloops Forest Regions indicate reductions over the next 20 years. Local mills may face additional pressure from mills in other areas of the province as the supply of timber tightens across the province and companies try to allocate the timber to its most efficient use.

8.4 Summary

The forest industry in the Robson Valley TSA is an important source of employment and income for local residents and supports approximately 37% of the TSA's total labour force. Other important sectors include the tourism- and business-related travel at 21% of the labour force, and the public sector at 20%.

The base case harvest forecast indicates that the current timber supply of 602 377 cubic metres per year could be maintained for one decade, before reductions of about 10% in each of decades two and three. The current AAC, if fully harvested and processed, can support some 600 person-years of direct forestry employment and a further 730 person-years of indirect and induced employment across the province. Residents of the TSA account for approximately 70% of the direct employment. Annual employment income related to the direct, indirect, and induced employment is approximately $52.8 million. Employment associated with the Robson Valley TSA harvest will likely remain relatively stable in the short term, unless the deficit in current mill capacity causes any earlier rationalization of the region's operations.

If the current taxation and stumpage rates remain on average the same as today, government revenues associated with the Robson Valley TSA could also be expected to remain the same for another decade. The current AAC can provide about $19.8 million in stumpage and related payments, other industry taxes, and provincial income taxes. In decades two and three, however, reductions to the revenues associated with the forest industry could decline by approximately $2 million per decade.

9 References

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10 Glossary

Allowable annual cut (AAC)

The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Base case forecast

The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

Biodiversity (biological diversity)

The diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

Biogeoclimatic (BEC) variant

A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

Biogeoclimatic zones

A large geographic area with broadly homogeneous climate and similar dominant tree species.

Clearcut harvesting

A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding.

Climax forest

A forest community that represents the final stage of natural forest succession.

Coniferous

Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.

Cutblock

A specific area, with defined boundaries, authorized for harvest.

Cutblock adjacency

The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.

Deciduous

Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Employment coefficient

The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Employment multiplier

An estimate of the total employment supported by each direct job; for example, a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

10 Glossary

Environmentally sensitive areas

Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.

Forest cover objectives

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green–up).

Forest cover requirements

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green–up).

Forest inventory

An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Forest Practices Code

Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Free-growing

An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Green-up

The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

Growing stock

The volume estimate for all standing timber at a particular time.

Harvest forecast

The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

Indirect and induced jobs

Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

Inoperable areas

Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Integrated resource management

The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

Land and Resource Management Plan (LRMP)

A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

Landscape-level biodiversity

The *Forest Practices Code Biodiversity Guidebook* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.

Landscape unit

A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Long-term harvest level

A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

Management assumptions

Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

Mean annual increment (MAI)

Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

10 Glossary

Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Partition	A portion of the AAC that is attributable to certain types of timber and/or terrain.
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Regeneration delay	The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Sensitivity analysis	A process that examines how uncertainty in data and management assumptions affect timber supply.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

The following tables and discussion outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Robson Valley TSA analysis. The information represents current forest management, or base case, assumptions for the area.

Current management is defined as the set of land-use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced, are not included in this appendix.

The purpose of the Timber Supply Review is to provide information on the effects of current management on both the short- and long-term timber supply in each timber supply area in the province. Any changes in the forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

More detail on the derivation of many of the land base exclusions and modelling approaches is available in the December 1998 *Robson Valley Timber Supply Area Timber Supply Review Data Package* (*Data Package*).

A.1 Inventories

The following inventories were used to determine the timber harvesting land base and the associated management themes for the timber supply analysis (Table A-1.)

Table A-1. Inventory information

Data	Source	Vintage	Update	Scale
Forest cover	Ministry of Forests (MoF)	1995	1998	1:20 000
Biogeoclimatic classification[a]	MoF	1986	1997	1:50 000
Natural disturbance type (NDT)[a]	MoF	1996	N/A	1:250 000
Visual landscape inventory	MoF	1994	1997	1:50 000
Proposed resource management zones (RMZ) (from draft LRMP)[a]	MoF	1995	1997	1:50 000
Proposed protected areas (from draft LRMP)[a]	MoF	1995	1997	1:20 000
Draft landscape units[a]	MoF	1995	1998	1:50 000
Draft biodiversity emphasis options[a]	MoF / Ministry of Environment, Lands and Parks (MELP)	1996	1998	1:50 000
Community watersheds	MELP	1994	—	1:50 000
Caribou habitat[a]	MELP	1985	1994	1:20 000
Recreation	MoF	1992	1997	1:50 000
Operability	MoF	1997	—	1:20 000
Planning cells	MoF	1996	1997	1;20 000
Administration: boundaries for region/district, timber supply area and blocks, public sustained yield units, agriculture land reserve, inventory region/ compartment	MoF	1993	1997	1:20 000
Severe and moderate risk armillaria root disease zones[a]	MoF	1995	—	1:20 000

(a) Non-standard layers.

A.1 Inventories

Data source and comments:

The forest cover inventory has been re-done since the last timber supply review and was completed in 1995-1996.

Biogeoclimatic classification was updated in 1997. Natural disturbance types have been derived from the biogeoclimatic classification.

The visual landscape inventory was completed by Ministry staff or consultants whose work was field checked by Regional staff.

Proposed resource management zones (RMZ) and protected areas from the *Land and Resource Management Plan* (LRMP) were used in the analysis. The plan was approved by government but has not yet been recognized by an Order-in-Council.

The Robson Valley Forest District and Ministry of Environment, Lands and Parks (MELP) staff developed draft landscape unit boundaries that are part of the LRMP.

The community watersheds are officially established by the Ministry of Environment, Lands and Parks.

The caribou maps identify caribou habitat as high quality, medium quality and corridor, and are included in the LRMP.

The recreation inventory was updated in 1996/1997 for the following mapsheets: 83D037, 038, 039, 040, 047, 048, 049, 054, 057, 058, 059, 062 063, 064, 065, 066, 067, 072, 073, 074, 075, 076, 077, 082, 084, 085, 086. The recreation inventory for the remainder of the mapsheets was adjusted in 1997 to remove the visual features component of the label.

The operability classification refers to the harvesting method that could be expected to be employed based on the slope of the land. The four operability classes are conventional (ground-based), cable, mixed cable and conventional, and inoperable. The operability classification was revised since the last timber supply analysis.

Planning cells were developed by the Robson Valley Forest District staff based on biophysical boundaries, and were designed to be of similar size.

The administration layers are standard corporate ownership layers.

Severe and moderate risk armillaria root disease zones were sketch mapped in 1994 by staff from the Prince George Forest Region office. In 1995 the areas were ground checked at 3% intensity, and in 1997 the maps were digitized. Plantations less than ten years old in 1994 were not old enough to show the effect of root disease. Also, infection centres in old cedar and hemlock stands are not visible from an aerial survey so the mapped armillaria root zones likely underestimate the full extent of the disease.

A.2 Zone and Analysis Unit Definitions

For the purpose of modelling current forest management, a number of resource emphasis groups were defined for this analysis. Table A-2. shows some of the groups and the reason for their creation.

A.2.1 Management zones (groups)

Table A-2. Groups definitions

Group	Objectives	Function
Visual quality	Established visual quality objectives 1. Preservation 2. Retention 3. Partial retention 4. Modification	Application of visual quality objective (VQO) guidelines by landscape unit. Total forest included.
Watersheds	Community watersheds. Resource management zone = C	Application of forest cover guidelines by landscape unit to community watersheds. All forested area included.
Caribou	Caribou habitat management zones 1. Medium[a] 2. Corridor	Application of forest cover guidelines by landscape unit. Total forest included.
Integrated resource management (IRM)	Integrated resource management (IRM)	Application of adjacency criteria by landscape unit. Timber harvesting land base outside of visual areas included.
Draft landscape units	Draft landscape units: Crescent Spur Northern Trench – West Twin Goat Lower Morkill – Cushing Forgetmenot Upper Morkill Holmes Raush South Trench Hugh Allan Milk Cariboo – Betty Wendle Dore Castle McBride – Dunster East Twin – McKale Horsey – Small – Swift Current Kiwa–Tete Canoe East Kinbasket West Kinbasket Foster Dawson	Application of biodiversity targets at the landscape unit/BEC zone-variant level. All crown forest included. Landscape unit-specific draft biodiversity emphasis options used in sensitivity analysis. Weighted average cover requirements used in base case.

(a) Areas classified as high quality caribou habitat were excluded from the timber harvesting land base.

Data source and comments:

See Section A.1, "Inventory information," for sources of mapping and zones referenced above.

A.2 Zone and Analysis Unit Definitions

A.2.2 Analysis units

An analysis unit represents a combination of stands dominated by specific tree species with a specific timber growing capability — as indicated by the inventory type group and site index in the forest inventory file. Each analysis unit is assigned its own timber volume projections (yield tables) for existing and future stands. Table A-3. defines the first level of division for analysis units (primary units), identified by the first two digits of the four-digit analysis unit code (see notes after Table A-4.).

Table A-3. Definition of primary analysis units

Analysis unit number first two digits	Analysis unit (leading species)	Inventory type groups	Biogeoclimatic zone	Additional criteria	Area
01	Spruce (Sx)	21–26	ESSF		66 959
02	Spruce (Sx)	21–26	ICH/SBS		32 219
03	Lodgepole pine (Pli)	27–32	ESSF		11 608
04	Lodgepole pine (Pli)	27–32	ICH/SBS		22 646
05	Douglas-fir (Fdi)	1–8	All	Except armillaria areas	9 339
06	Subalpine fir (Balsam) (Bl)	18–20	ESSF		30 969
07	Subalpine fir (Balsam) (Bl)	18–20	ICH/SBS		5 487
08	Western redcedar (Cw)	9–11	All	Except supply blocks A, B, I, and J	5 664
09	Western hemlock (Hw)	12–17	All	Except supply blocks A, B, I, and J	6 821
10	Deciduous (Dec.)	35–42	All		7 924
11	Cedar (Cw) (Cw-Hw partition)	9–11	ICH	Supply blocks A, B, I, and J	8 643
12	Hemlock (Hw) (Cw-Hw partition)	12–17	ICH	Supply blocks A, B, I, and J	3 986
13	Douglas-fir (Fdi)	1–8		Armillaria moderate zone	561
14	Douglas-fir (Fdi)	1–8		Armillaria severe zone	558

A.2 Zone and Analysis Unit Definitions

Productivity is represented by the third digit (good = 1, medium = 2, poor = 3, all = 0) and age of stands (< 141 years = 1, > 140 years = 2, and managed stands = 3) by the fourth digit. All stands aged 1-10, are placed on managed stand curves, 95% of stands aged 11-20 are placed on managed stand curves, and 83% of stands aged 21-30 years are on managed stand curves. A full listing of analysis units, and transfer following harvest is shown in Table A-4.

A.2 Zone and Analysis Unit Definitions

Table A-4. Full list of analysis units and the transfer following harvest

Species – site class	BEC zone	Age (years)	Inventory type group	Site index	Thrifty analysis unit	Old analysis unit	Managed stand analysis unit
Spruce – 1	ESSF	1-140	21-26	> 15	0111	–	0113
Spruce – 2	ESSF	1-140	21-26	9-15	0121	–	0123
Spruce – 3	ESSF	1-140	21-26	< 9	–	–	0133
Spruce – 1	ESSF	141+	21-26	> 15		0112	0113
Spruce – 2	ESSF	141+	21-26	9-15		0122	0123
Spruce – 3	ESSF	141+	21-26	< 9		0132	0133
Spruce – 1	ICH/SBS	1-140	21-26	> 17	0211	–	0213
Spruce – 2	ICH/SBS	1-140	21-26	11-17	0221	–	0223
Spruce – 3	ICH/SBS	1-140	21-26	< 11	–	–	0233
Spruce – 1	ICH/SBS	141+	21-26	> 17		0212	0213
Spruce – 2	ICH/SBS	141+	21-26	11-17		0222	0223
Spruce – 3	ICH/SBS	141+	21-26	< 11		0232	0233
Pine – 1	ESSF	1-140	27-34	> 15	0311	–	0313
Pine – 2	ESSF	1-140	27-34	= < 15	0321	–	0323
Pine – 1	ESSF	141+	27-34	> 15		–	–
Pine – 2	ESSF	141+	27-34	= < 15		0322	0323
Pine – 1	ICH/SBS	1-140	27-34	> 19	0411	–	0413
Pine – 2	ICH/SBS	1-140	27-34	16-19	0421	–	0423
Pine – 3	ICH/SBS	1-140	27-34	< 16	0431	–	0433
Pine – 1	ICH/SBS	141+	27-34	> 19		–	–
Pine – 2	ICH/SBS	141+	27-34	16-19		0422	0423
Pine – 3	ICH/SBS	141+	27-34	< 16		0432	0433
Fir – 1	All	1-140	1-8	> 19	0511	–	0513
Fir – 2	All	1-140	1-8	= < 19	0521	–	0523
Fir – 1	All	141+	1-8	> 19		–	–
Fir – 2	All	141+	1-8	= < 19		0522	0523
Balsam – 1	ESSF	1-140	18-20	> 13	0611	–	0613
Balsam – 2	ESSF	1-140	18-20	9-13	0621	–	0623
Balsam – 3	ESSF	1-140	18-20	< 9	–	–	0633
Balsam – 1	ESSF	141+	18-20	> 13		–	–
Balsam – 2	ESSF	141+	18-20	9-13		0622	0623
Balsam – 3	ESSF	141+	18-20	< 9		0632	0633
Balsam – 1	ESSF	1-140	18-20	> 16	0711	–	0713
Balsam – 2	ESSF	1-140	18-20	11-16	0721	–	0723
Balsam – 3	ESSF	1-140	18-20	< 11	–	–	0733
Balsam – 1	ESSF	141+	18-20	> 16		–	–
Balsam – 2	ESSF	141+	18-20	11-16		0722	0723
Balsam – 3	ESSF	141+	18-20	< 11		0732	0733

(continued)

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.2 Zone and Analysis Unit Definitions

Table A-4. Full list of analysis units and the transfer following harvest (concluded)

Species – site class	BEC zone	Age	Inventory type group	Site index	Thrifty analysis unit	Old analysis unit	Managed stand analysis unit
Cedar – 1	All	All	9-11	> 15		0812	0813
Cedar – 2	All	All	9-11	= < 15		0822	0823
Hemlock	All	All	12-17	All	0901	0902	0903
Deciduous – 1	All	All	> 34	> 21	1011	–	1013
Deciduous – 2	All	All	> 34	17-21	1021	–	1023
Deciduous – 3	All	All	> 34	< 17	1031	–	1033
Cedar – 1 (Part)	All	All	9-11	> 15	–	1112	1113
Cedar – 2 (Part)	All	All	9-11	= < 15	–	1122	1123
Hemlock – 1 (Part)	All	All	9-11	> 12	–	1212	1213
Hemlock –2 (Part)	All	All	9-11	= < 12	–	1222	1223
Fir – 1 Arm, Moderate	All	All	1-8	All	1301	–	1303
Fir – 1 Arm, Severe	All	All	1-8	All	1401	–	1403

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.3 Definition of the Timber Harvesting Land Base

A.3.1 Land not administered by the British Columbia Forest Service for timber supply

Ownership codes 62 and 69 (OWNER) and ownership character code C (OWNER_CH) on the inventory file were used to define areas managed by the B.C. Forest Service. All areas with other ownership codes were removed from the land base considered available for timber supply. This includes areas under woodlot licences as their allowable annual cuts (AAC) are determined independently of the timber supply review process.

Some areas were incorrectly identified as crown land on the inventory file. The following areas were re-classified and excluded from the analysis:

- the area of the LaSalle Lake Recreation Reserve defined by mapsheet 93H057
- polygons 511, 586, 587, 578, 575, 576, 13, 577, 732, 731, 470, 685, 476, 584, 469, and 471.

A.3.2 Land classified as non-forest

Non-forest (TYPID_PR = 6) and non-typed (TYPID_PR = 8) areas were excluded from the land base considered for timber supply.

A.3.3 Non-commercial cover

Non-commercial brush types (TYPID_PR = 5) were excluded from the area considered available for timber harvesting.

A.3.4 Inoperable areas

The inventory file contains an operability classification for the Robson Valley TSA. All areas which are classified as inoperable or untyped (OPERABLE = I or N) or as alpine tundra (zone=AT) were excluded from the area considered available for timber harvesting. Operability codes were also used in defining non-merchantable forest types (see Section A.3.7, "Non-merchantable mature forest stands").

A.3.5 Environmentally sensitive areas

Some forest lands are environmentally sensitive and/or significantly valuable for other resources. These areas are identified and delineated during a forest inventory as environmentally sensitive areas (ESAs). The ESA system uses the following classification: soil (Es), forest regeneration problems (Ep), snow avalanche (Ea), recreation (Er), and wildlife (Ew). Two ESA categories are recognized: high (ESA1) and moderately sensitive (ESA2).

The following table lists the per cent area of each classification excluded from the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

Table A-5. Description of environmentally sensitive areas

ESA category	ESA description	Reduction per cent (%)
Es1	Soil sensitivity: terrain stability class V terrain	90
Es2	Soil sensitivity: terrain stability class IV terrain	10
Ep1 and 2	Forest regeneration problems	90
Ea1	Snow avalanche	90
Er1	Recreation	100
Ew1 and 2	Wildlife	10

A.3.6 Immature stands with low timber growing potential

For the conventional operability code (OPERABLE=A) the site indices provided in Table A-6. reflect the minimum productivity required for those species to attain 140 cubic metres per hectare by 140 years of age (100 years for deciduous species).

For the mixed and cable operability codes (OPERABLE=M, C) the site indices provided in Table A-6. reflect the minimum productivity required for those species to attain 200 and 250 cubic metres per hectare by 140 years of age, respectively.

Immature stands (defined as 140 years and younger for coniferous and 100 years and less for deciduous) that do not meet the criteria were removed from the timber harvesting land base. Where the history attribute code indicated the occurrence of plantation, site preparation, or stand tending activities, (ATTRIBUT = PL, SI, ST) then the stand remained part of the timber harvesting land base regardless of its productivity. Similarly, where the history activity code indicates that a stand has been disturbed by logging (ATTRIBUT = DI and ACTIVITY = L), it remained part of the timber harvesting land base.

Table A-6. Site index exclusions for immature stands

	Site index (SI_{50}) criteria for immature stands (m @ 50 years)								
	< 140 years of age						< 100 years of age		
Operability code	Douglas-fir	Cedar	Hemlock	Balsam	Spruce	Pine	Aspen	Birch	Cottonwood
Conventional (A)	< 12.6	< 11.2	< 8.4	< 8.9	< 7.9	< 8.1	< 15.4	< 16.6	< 14.2
Mixed (M)	< 14.8	< 13.8	< 10.2	< 11.0	< 9.9	< 10.3	No harvest	No harvest	No harvest
Cable (C)	< 16.4	< 15.8	< 11.8	< 12.6	< 11.8	< 12.3	No harvest	No harvest	No harvest

A.3 Definition of the Timber Harvesting Land Base

A.3.7 Non-merchantable mature forest stands

Non-merchantable forest types are stands which contain non-commercial species, low timber volumes, or have low productive potential for timber. Operable deciduous-leading stands remain in the timber harvesting land base to support a deciduous partition of the allowable annual cut for the Robson Valley TSA. Therefore, mature deciduous-leading stands that have attained minimum height and volume criteria remained in the analysis in order to assess the deciduous timber supply. Mature coniferous stands that have not reached minimum height or volume criteria were excluded from the timber harvesting land base. Table A-7. summarizes the merchantability cut-offs for mature stands.

Table A-7. Mature stand exclusions

Type groups	Age class	Volume (m^3/hectare)	Height class	Stocking class	Operability code
1-8 (Douglas-fir)	≥ 7		2	1 or 2	All
	≥ 7		1	All	All
9-11 (Cedar)	≥ 7		< 3	All	All
12-17 (Hemlock)	≥ 6		< 3	All	All
18-20 (Balsam)	≥ 6		4	2	C
	≥ 6		3	2	All
	≥ 6		2	1 or 2	All
	≥ 6		1	All	All
21-26 (Spruce)	≥ 7		2	1	C
	≥ 7		2	2	All
	≥ 7		1	All	All
27-31 (Pine)	≥ 5		3	3	C
	≥ 5		3	4	All
	≥ 5		2	1	M, C
	≥ 5		2	2-4	All
	≥ 5		1	All	All
1-34 (All coniferous species)	≥ 8	< 250	All	All	C
	≥ 8	< 200	All	All	M
	≥ 8	< 140	All	All	A
35-42 (Deciduous)	All	All	All	All	M, C
	≥ 4	All	< 3	All	A
	≥ 4	All	All	> 1	A
	≥ 6	< 140	All	All	A
9-11 (Cedar) and 12-17 (Hemlock), supply blocks A, B, I, J	All	All	All	All	M, C

Data source and comments:

Age class: 4 = 61-80 years; 5 = 81-100 years; 6 = 101-120 years; 7 = 121-140 years;

Height class: 1 = 0.1-10.4 metres; 2 = 10.5-19.4 metres; 3 = 19.5-28.4 metres; 4 = 28.5-37.4 metres;

Operability code: A = conventional, C = cable, M = mixed cable and conventional, I = inoperable.

A.3 Definition of the Timber Harvesting Land Base

A.3.8 Riparian management and reserve zones

Riparian reserves were 100% excluded from the timber harvesting land base. The total area of the timber harvesting land base affected by riparian management was defined by extrapolation from riparian assessments conducted on four mapsheets in the Robson Valley TSA.

These assessments showed that the total operable forested area (i.e., the following types of area removed: non-TSA, non-productive, non-commercial, ESAs, inoperable, non-merchantable), at this point in the netdown, was 22 751 hectares for the four mapsheets assessed for riparian habitat. Of that, 1347 hectares are affected by riparian reserves. This represents a reduction to the operable land base of 5.92%. In addition, 626.84 hectares are affected by riparian management zones, representing a reduction to the land base of 2.76% (which reflects the percentage cover retention for different stream classes). Both of these numbers are slightly different from the published data package, as netdowns changed slightly, affecting the total operable forest and thus the calculated percentages.

To account for the forest area that will be left unharvested in riparian management and reserve zones, the timber harvesting land base was therefore reduced by 8.68% (5.92% + 2.76%).

A.3.9 Areas considered inaccessible

Some stands with merchantable timber are located in areas which are inaccessible. These areas were removed from the timber harvesting land base, and include upper Nevin (King) Creek, and Baker (Holliday) Creek, defined by planning cells (PLANCELL) B029 and B031.

A.3.10 Areas with high recreation values

Areas with a recreation management class '1' that coincide with a visual quality objective (VQO) were modelled with the forest cover requirements of the VQO. Areas that did not coincide with a VQO, were treated as follows: 50% of each area with a recreation feature significance 'B' (high), (REC_MGTC = 1 and REC_SIG = B) was excluded from the timber harvesting land base; 37.5% of each area with feature significance 'C' (moderate), (REC_MGTC = 1 and REC_SIG = C) was excluded from the timber harvesting land base. See the *Data Package* for additional details on the modelling approach used.

A.3.11 Caribou high habitat

All areas designated as high quality caribou habitat (CARIB = H) in the LRMP were excluded from the timber harvesting land base.

A.3.12 Existing and future unclassified roads, trails and landings

All highways and larger municipal roads are of a sufficient size to be mapped as polygons and classified as non-forest areas in the forest inventory file. These polygons were thus removed from the timber harvesting land base as non-forest area, as discussed in Section A.3.2, "Land classified as non-forest."

Separate estimates were made to reflect the loss in productive forest land due to unclassified existing and future roads, trails and landings (RTL). Existing RTL estimates were applied as reductions to the current productive forest considered available for harvesting, and future RTL estimates were applied after stands were projected for harvest for the first time in the timber supply model.

Existing RTL were estimated at 2.35% of the current total productive forest available for harvest, at this point in the netdown process. All existing RTLs were assumed to come from age class 0, 1 and 2. When the 2.35% reduction for the current total productive forest available for harvesting is removed, the result is a 12.9% reduction from age class 0, 1 and 2. The RTL of 2.35% has changed slightly from the published data package, due to small changes in the amount of productive forest available for harvest at this point in the netdown process.

To account for future RTL, a reduction of 6.9% was applied to all stands > age class 2, after they were harvested for the first time in the timber supply model.

A.3 Definition of the Timber Harvesting Land Base

A.3.13 Stand-level biodiversity

Wildlife tree patches are retained on cutblocks within the Robson Valley TSA to provide for the maintenance of stand structure over time. The Robson Valley Forest District staff calculated that 8% of the forested area in each landscape unit is required for stand-level biodiversity. It is estimated that three-quarters of this target can be met from forest outside the timber harvesting land base. Consequently, the timber harvesting land base was further reduced by 2% to account for stand-level biodiversity.

A.3.14 Retention for grizzly bear habitat

South and west facing slide chutes in the ESSF zone have been identified as grizzly bear habitat in the Robson Valley TSA. To protect this habitat, the current policy has been to retain 50-metre wide buffers on these slide chutes. To account for these buffers a 1% reduction was applied to the current productive forest available for harvest.

A.3.15 Protected area exclusions

Ten protected areas are outlined in the Robson Valley *Land and Resource Management Plan* (LRMP) that has been approved by government. These areas are excluded from the timber harvesting land (RMZGLET = P).

A.4 Forest Management Assumptions

A.4.1 Utilization levels

The utilization level defines the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species, and is used in the analysis to calculate merchantable volume. Table A-8. lists the utilization limits used in this analysis.

Table A-8. Utilization levels

Analysis unit	Utilization		
	Minimum diameter at breast height (DBH) (cm)	Maximum stump height (cm)	Minimum top diameter inside bark (dib) (cm)
Lodgepole pine (Pli)	12.5	30.0	10.0
All other conifers and deciduous trees	17.5	30.0	10.0 a,b

(a) Western redcedar is actually utilized to a 15 cm dib but this was not reflected in the analysis because data for modelling were unavailable.

(b) For deciduous species, the top diameter was 10 cm or, where the branching habit of the species dictates, utilization to the first major branches. If deciduous-leading stands are harvested, the volume is charged to the deciduous partition and to the licensee's allowable cut.

A.4.2 Volume exclusions for mixed coniferous- deciduous-stands

All deciduous species were excluded from the estimation of volume in coniferous-leading stands mixed with deciduous species. All stands dominated by deciduous species were grouped into deciduous-leading analysis units (AUs) and contribute toward the estimate of stand volume modelled for the deciduous partition.

A.4.3 Minimum harvestable age

The minimum harvestable age defines the earliest age at which a stand may be harvested, not the age at which harvesting must occur. For this analysis, minimum harvest age was defined as the age at which stands attained a specified volume for a given operability classification (see Table A-9).

Table A-9. Minimum volume per hectare to be considered harvestable

Inventory operability description	Code	Minimum volume to be harvestable (m^3/hectare)
Conventional	A	140
Mixed conventional / cable	M	200
Cable	C	250

A.4 Forest Management Assumptions

Minimum harvestable age was specified by analysis unit (AU), so to generate a minimum harvestable age, all stands in an analysis unit had a minimum volume assigned, based on operability, which were area-weighted together to produce a single minimum volume of each analysis unit. This minimum volume was then compared to the appropriate yield table to determine the age at which the minimum volume was attained, and this age became the minimum harvestable age. Table A-10. shows the minimum volume, minimum harvestable age, and the age at which 95% of culmination volume is attained for the AUs used in the Robson Valley TSA.

The area-weighted minimum volume and resulting minimum harvestable age for managed AUs represents all stands currently in that AU, plus those that will be transferred to that AU following harvest.

A.4 Forest Management Assumptions

Table A-10. Minimum volume and harvestable ages

Analysis unit number	Species	Area weighted minimum volume (m^3/hectare)	Minimum harvestable age (years)	Culmination age (years)
0111	Sx	180	80	100
0112	Sx	172	80	110
0113	Sx	174	70	100
0121	Sx	162	120	150
0122	Sx	175	130	160
0123	Sx	169	110	160
0132	Sx	168	180	240
0133	Sx	167	160	240
0211	Sx	161	70	100
0212	Sx	161	70	100
0213	Sx	160	60	90
0221	Sx	162	90	130
0222	Sx	167	100	140
0223	Sx	162	100	130
0232	Sx	174	150	200
0233	Sx	170	150	200
0311	Pl	176	80	90
0313	Pl	175	70	100
0321	Pl	173	100	120
0322	Pl	172	90	110
0323	Pl	172	90	130
0411	Pl	163	60	80
0413	Pl	162	50	80
0421	Pl	167	80	100
0422	Pl	175	70	90
0423	Pl	165	70	90
0431	Pl	167	90	120
0432	Pl	157	90	120
0433	Pl	164	90	120
0511	Fdi	167	70	100
0513	Fdi	165	50	80

(continued)

A.4 Forest Management Assumptions

Table A-10. Minimum volume and harvestable ages

Analysis unit number	Species	Area weighted minimum volume (m^3/hectare)	Minimum harvestable age (years)	Culmination age (years)
0521	Fdi	171	90	130
0522	Fdi	183	100	130
0523	Fdi	174	80	110
0611	Bl	185	90	110
0613	Bl	181	80	120
0621	Bl	155	130	170
0622	Bl	171	150	170
0623	Bl	169	120	170
0632	Bl	150	180	220
0633	Bl	150	140	210
0711	Bl	180	70	100
0713	Bl	173	70	100
0721	Bl	170	120	150
0722	Bl	152	110	150
0723	Bl	159	100	150
0732	Bl	156	140	190
0733	Bl	156	130	180
0812	Cw	175	70	90
0813	Cw	172	80	110
0822	Cw	180	110	100
0823	Cw	179	110	140
0901	Hw	193	90	110
0902	Hw	177	100	140
0903	Hw	179	100	140
1011	Deciduous	140	70	90
1013	Deciduous	140	60	90
1021	Deciduous	140	90	100
1023	Deciduous	140	80	110
1031	Deciduous	140	110	110
1033	Deciduous	140	220	120

(continued)

Table A-10. Minimum volume and harvestable ages (concluded)

Analysis unit number	Species	Area weighted minimum volume (m^3/year)	Minimum harvestable age (years)	Culmination age (years)
1112	Cw	140	70	80
1113	Cw	140	80	110
1122	Cw	140	90	90
1123	Cw	140	90	140
1212	Hw	140	80	100
1213	Hw	140	90	130
1222	Hw	140	100	160
1223	Hw	140	110	170
1301	Fdi	153	100	130
1303	Fdi	149	80	110
1401	Fdi	169	90	120
1403	Fdi	166	70	100

A.4.4 Harvest scheduling priorities

Priority for harvest was highest for stands that were the oldest relative to the applicable minimum harvestable age. This is termed a "relative oldest first" harvest rule.

A priority was also placed on harvesting 6000 cubic metres per year from deciduous-leading forest types.

A.4.5 Unsalvaged losses

Table A-11. shows the estimated average annual unsalvaged volume loss to catastrophic events such as insect epidemics, fires, wind or other agents over the long term on the timber harvesting land base. The unsalvaged loss column reflects only areas in which the volume will not be recovered or salvaged.

Table A-11. Unsalvaged losses

Cause of loss	Losses on the timber harvesting land base (m^3/year)	Salvaged volume (m^3/year)	Unsalvaged losses (m^3/year)
Insect (except hemlock looper)	21 208	7 263	13 945
Hemlock looper	94 667	55 556	39 111
Disease	5 000	2 250	2 750
Wind damage	4 125	2 000	2 125
Fire	55 023	20 350	34 673
Total	180 023	87 419	92 604

To accommodate unsalvaged losses in timber supply modelling, 92 604 cubic metres of harvested volume was subtracted from the timber supply forecast annually before it was reported. The unsalvaged losses were assumed to be constant over the timber supply forecast period.

A.4.6 Deferral of seed production stands

Seed production stands, with a total area of 1723 operable hectares have been identified as sources of better than average spruce and Douglas-fir seed and were deferred from harvest for 70 years.

A list of polygons identifying the seed production stands can be obtained from the Robson Valley Forest District.

A.4.7 Managed stand regeneration assumptions

Existing managed stands are those areas of immature forest with a planting history. The majority of stands less than 30 years old are considered managed as indicated in Table A-12. Stands over 10 years of age and less than 30 were split into a managed and unmanaged components based on the percentages in Table A-12. The unmanaged component was placed on the corresponding unmanaged analysis unit.

Table A-12. Immature plantation history

	Area managed (%)		
Analysis unit	Age 1 – 10	Age 11 – 20	Age 21 – 30
All	100	95	83

Recent plantation growth, and future stand development for coniferous analysis units was projected using managed stand yield tables (MSYTs) produced using the B.C. Forest Service growth and yield model, Table Interpolation Program for Stand Yields (Batch TIPSY version 2.1 alpha 5). Table A-13. provides the regeneration assumptions by primary analysis units and lists the inputs used to TIPSY.

A.4 Forest Management Assumptions

Table A-13. Regeneration assumptions by analysis unit

#	Analysis unit	BEC zone	Regenerates to %	Regenerated stands	Regen delay	OAF 1	OAF 2	Type	%	Initial density
01	Sx	ESSF	100	Sx76Bl21Pl13	4	15	5	Plant	100	1450
02	Sx	ICH/SBS	100	Sx77Fd8Bl6Pl6Cw3	4	25	5	Plant	100	1450
03	Pl	ESSF	100	Sx66Pl21Fd13	4	15	5	Plant	100	1450
04	Pl	ICH/SBS	82	Pl64Fd21Sx10Bl4Cw1	4	15	5	Plant	100	1450
			18	Sx66Pl20Bl14	4	25	5	Plant	100	1450
05	Fdi	All	82	Fd42Pl38Sx14Cw6	4	15	5	Plant	100	1450
			18	Sx75Cw20Fd5	4	25	5	Plant	100	1450
06	Bl	ESSF	100	Sx85Bl10Pl5	4	15	5	Plant	100	1450
07	Bl	ICH/SBS	44	Sx77Fd18Pl5	4	25	5	Plant	100	1450
			56	Bl37Sx25Pl28Fd10	4	15	5	Plant	100	1450
08	Cw	All	16	Fd41Bl21Sx17Cw15Pl6	4	15	5	Plant	100	1450
			84	Sx87Cw6Fd3Bl4	4	25	5	Plant	100	1450
09	Hw	All	100	Sx75Hw14Cw11	4	25	5	Plant	100	1450
10	Deciduous	All	100	Ep40At30Ac10Sx10Fd10	4	15	5	Plant	100	1450
11	Cw (partition)	ICH		As for AU 08 (Cw)						
12	Hw (partition)	ICH		As for AU 09 (Hw)						
13	Fdi – Armillaria[a] moderate	All		As for AU 05 (Fdi)	4	15	10	Plant	100	1450
14	Fdi – Armillaria[a] severe	All		As for AU 05 (Fdi)	4	15	20	Plant	100	1450

(a) Armillaria root disease incidence has two ratings: moderate (2-10%, average 5%) which relates to scattered incidence, and severe (10% and greater, average 15%) which relates to concentrated incidence of large patches. The Prince George regional pathologist estimates that on average the volume reduction will be 20 to 25% over a rotation, however, further surveys and research are needed. OAF 2 has been adjusted to account for the estimated volume reductions.

A regeneration delay of 3 years was used in the timber supply model to reflect that planted seedlings were one year old. Managed stands were returned to the same species composition.

A.4 Forest Management Assumptions

A.4.8 Not satisfactorily restocked (NSR) areas

Land classified in the Robson Valley TSA FIP file as type identity 4 or 9 (TYPID_PR = 4, 9) is included in the current timber harvesting land base and was used to define NSR for the analysis. Table A-14. lists the amount of NSR that was present in the timber harvesting land base (5220 hectares), how much was treated as backlog and current NSR, and the number of years before stands would be established on these sites.

Table A-14. Not satisfactorily restocked (NSR) areas

Backlog NSR		Current NSR	
Years to regenerate	Area (hectares)	Years to regenerate	Area (hectares)
10	1 444	4	3 776

A.4.9 Forest cover requirements — resource emphasis areas

The timber supply model used in this analysis (FSSIM Version 3.0) can incorporate forest cover requirements that specify both the maximum proportion of an area allowed in a disturbed condition, and the minimum required area of old-age forest. The forest cover requirements applied in the analysis approximate current forest management practices. The following cover requirements were applied to each resource emphasis group within each landscape unit.

Table A-15. Forest cover requirement for resource emphasis areas

Zone or group	Maximum allowable disturbance (% area)	Green-up height (metres)	Minimum retained area (%)	Minimum age for retention	Land base constraints apply to
VQO = preservation	1.0	5			Crown forested area
VQO = retention	3.5	5			Crown forested area
VQO = partial retention	10.5	5			Crown forested area
VQO = modification	20.5	5			Crown forested area
VQO = maximum modification	33	5			Crown forested area
Community watersheds	5	3			Crown forested area
Caribou = medium	33	3	67	80	Crown forested area
Caribou = corridor	20	3	20	100	Crown forested area
Integrated resource management	33	3			Timber harvesting land base

A.4 Forest Management Assumptions

A.4.10 Forest cover requirements — landscape-level biodiversity

Landscape units in the Robson Valley and their biodiversity emphasis, have not been formally approved. Therefore a single weighted constraint for the retention of old-growth forests, based on the anticipated distribution of 45% lower, 45% medium and 10% higher biodiversity emphasis, was applied to each draft landscape unit in the base case. The values in Table A-16. are based on initially achieving one-third of the *Landscape Unit Planning Guide* old-seral stage constraint in the low-emphasis portion. The requirements are phased-in over time to ensure that the full requirement for retention of old-seral forest will be met by the end of three 70-year rotations (the requirements are applied at the beginning of each 70-year period to ensure they are met by the end of the period).

Table A-16. Forest cover requirements for landscape unit biodiversity in the base case (applied to gross productive forest)

Biogeoclimatic unit	NDT	Old-seral stage minimum retention area by decade (%)			Minimum age (years)
		1	7	14	
ESSF	1	14.2	17.1	19.9	250
ICH	1	9.7	11.7	13.6	250
ESSF	2	6.7	8.1	9.4	250
ICH	2	6.7	8.1	9.4	250
SBS	2	6.7	8.1	9.4	250
SBS	3	8.2	9.9	11.5	140

A.5 Volume Estimates for Existing Stands

The variable density yield projection model (VDYP), version 6.5a, developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural coniferous stands, and both existing and future deciduous stands. Table A-17. shows the volume estimates by analysis unit for existing natural stands.

A.5 Volume Estimates for Existing Stands

Table A-17. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	0111	0112	0121	0122	0132	0211	0212	0221	0222
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0
40	13	9	0	0	0	19	14	1	1
50	59	46	3	2	0	76	69	13	8
60	112	100	21	11	0	132	124	50	33
70	159	148	47	33	1	182	173	90	74
80	200	190	77	65	4	225	215	128	114
90	236	226	108	96	14	262	250	163	148
100	266	256	135	124	32	293	279	193	178
110	293	282	161	150	52	319	304	220	204
120	315	304	183	173	72	341	324	244	226
130	337	325	205	195	92	362	344	266	248
140	354	343	224	215	111	379	361	286	269
150	370	359	241	233	129	394	376	303	287
160	383	373	257	249	146	406	388	318	303
170	394	386	271	264	162	417	399	331	318
180	404	397	283	278	177	426	409	343	331
190	412	407	295	291	191	434	417	354	343
200	420	416	305	302	204	442	425	363	354
210	428	424	315	313	217	449	432	373	365
220	434	431	324	323	229	455	439	381	374
230	440	438	332	332	240	461	445	389	383
240	446	444	340	340	251	466	450	396	392
250	451	449	347	348	261	471	455	403	399
260	454	453	352	353	267	473	458	407	404
270	456	456	356	357	273	476	460	410	407
280	458	458	360	362	279	478	462	414	411
290	460	460	363	366	284	480	464	417	414
300	462	462	367	369	289	481	465	419	417
310	464	464	369	373	294	483	466	422	420
320	465	465	372	376	299	484	467	424	422
330	466	467	375	378	303	485	468	426	424
340	467	468	377	381	307	486	469	428	426
350	468	469	379	383	310	487	470	429	428

(continued)

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.5 Volume Estimates for Existing Stands

Table A-17. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	0232	0311	0321	0322	0411	0421	0422	0431	0432
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	12	2	3	34	6	11	0	1
40	0	58	14	26	89	51	61	18	18
50	0	102	45	60	138	93	107	52	54
60	2	140	77	94	181	131	147	85	87
70	8	175	105	125	219	165	182	116	117
80	26	205	132	152	252	195	213	143	145
90	49	232	156	177	281	222	240	169	171
100	75	257	178	200	308	247	265	192	194
110	99	279	198	221	333	270	288	214	215
120	122	300	217	240	356	292	309	235	235
130	145	320	235	258	377	312	329	254	255
140	166	333	248	271	390	325	343	268	268
150	186	344	259	282	401	336	354	278	279
160	204	351	267	290	409	343	362	286	288
170	221	356	272	296	413	348	368	291	294
180	237	358	275	299	414	350	370	294	297
190	252	358	276	300	413	349	371	294	298
200	266	361	279	304	415	351	374	297	302
210	279	364	283	307	418	354	377	300	305
220	291	367	286	310	420	357	381	303	309
230	302	370	289	314	423	359	384	305	312
240	313	372	292	317	426	362	387	308	315
250	323	375	295	319	428	364	390	311	318
260	330	377	297	321	430	366	392	313	321
270	335	379	298	323	432	368	394	315	323
280	340	380	300	325	434	370	396	316	325
290	345	382	302	327	436	371	397	318	326
300	350	383	303	328	437	373	399	319	328
310	354	385	304	329	439	374	400	320	329
320	358	386	305	330	440	375	401	321	331
330	362	387	306	331	441	376	402	322	332
340	365	388	307	332	442	377	403	323	333
350	368	388	307	333	443	378	404	324	333

(continued)

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.5 Volume Estimates for Existing Stands

Table A-17. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	0511	521	0522	0611	0621	0622	0632	0711	0721
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	13	0	0	4	0	0	0	9	0
40	60	16	12	25	1	1	0	49	8
50	108	49	43	59	12	9	0	96	28
60	154	83	77	95	29	25	5	139	52
70	197	117	111	131	54	50	17	181	79
80	237	148	142	161	75	71	32	217	102
90	274	177	171	187	94	91	47	249	121
100	307	204	198	212	111	109	61	277	140
110	336	230	223	234	127	125	75	303	157
120	361	253	244	254	143	141	87	326	173
130	383	274	265	276	158	156	100	351	190
140	403	292	284	296	173	171	112	373	206
150	421	307	300	314	187	185	123	393	221
160	436	321	315	331	200	199	134	412	236
170	450	332	328	347	213	212	145	429	250
180	462	342	340	362	225	224	155	445	263
190	473	351	351	376	236	236	164	459	275
200	484	360	362	390	248	247	174	474	287
210	494	369	373	403	258	258	183	488	299
220	504	377	383	415	269	269	192	501	310
230	514	385	393	427	279	279	200	513	321
240	523	393	402	439	288	289	208	525	331
250	531	400	411	450	298	298	216	537	341
260	532	401	413	452	299	300	218	540	343
270	532	402	414	454	301	302	220	542	345
280	533	403	416	456	303	304	221	545	346
290	533	404	417	458	304	305	223	547	348
300	534	405	419	459	305	307	224	549	349
310	534	406	420	461	307	308	225	551	351
320	534	406	421	462	308	310	226	553	352
330	534	407	422	463	309	311	228	555	353
340	534	407	423	465	310	312	229	557	354
350	534	407	424	466	311	313	230	558	355

(continued)

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.5 Volume Estimates for Existing Stands

Table A-17. Timber volume tables for existing natural stands (cubic metres/hectare)

Age (years)	0722	0732	0812	0822	0901	0902	1011	1021	1031
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	0	0	0	1	0	7	0	0
40	4	0	37	5	11	2	43	13	2
50	20	5	88	36	45	15	84	43	21
60	46	16	134	72	93	48	123	74	46
70	79	39	176	104	143	91	159	105	71
80	106	61	214	133	188	132	189	131	94
90	129	80	242	156	225	167	216	156	115
100	150	98	265	175	255	196	236	175	133
110	169	115	284	191	281	221	252	191	147
120	187	130	298	204	302	241	264	202	158
130	205	146	321	222	326	265	273	210	167
140	223	161	343	239	348	286	281	217	174
150	239	176	364	255	367	306	288	223	180
160	255	190	383	270	384	323	290	225	182
170	270	203	401	284	398	338	292	227	184
180	285	216	418	297	411	352	294	228	185
190	299	228	435	310	422	365	295	229	186
200	312	240	451	322	434	377	297	231	187
210	325	251	466	334	444	389	298	232	188
220	337	263	484	347	455	401	300	233	190
230	349	273	502	361	464	412	301	234	191
240	360	284	519	374	473	422	302	235	192
250	371	294	536	388	481	432	303	236	192
260	374	296	538	390	486	437	304	236	193
270	376	298	540	392	490	442	304	237	193
280	378	300	542	394	494	447	304	237	193
290	379	301	543	396	498	451	304	237	194
300	381	303	545	398	501	454	304	237	194
310	383	304	546	400	504	458	305	238	194
320	384	306	548	401	507	461	305	238	194
330	385	307	549	403	510	464	305	238	194
340	387	308	550	404	513	467	305	238	194
350	388	309	551	406	515	469	305	238	194

(continued)

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.5 Volume Estimates for Existing Stands

Table A-17. Timber volume tables for existing natural stands (cubic metres/hectare) (concluded)

Age (years)	1112	1122	1212	1222	1301	1401
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	1	0	0	0	1	3
40	34	5	5	0	13	24
50	82	38	32	1	39	58
60	126	73	83	13	66	93
70	165	105	133	48	92	127
80	200	134	178	86	118	159
90	222	153	213	121	142	189
100	238	166	241	151	165	217
110	248	176	263	175	186	244
120	254	181	281	196	205	267
130	273	196	305	220	223	288
140	291	211	325	242	237	306
150	309	226	344	262	249	321
160	325	239	361	280	259	333
170	340	251	376	296	268	344
180	354	263	389	311	275	353
190	368	274	400	324	282	361
200	381	285	412	337	289	369
210	394	296	423	350	296	377
220	409	308	434	362	302	385
230	424	320	444	373	308	392
240	439	332	453	384	314	399
250	453	344	462	394	319	406
260	455	345	466	401	319	406
270	456	347	470	408	320	406
280	458	349	474	414	320	407
290	459	351	477	419	320	407
300	460	352	480	424	321	407
310	461	353	483	428	321	407
320	463	355	486	432	321	406
330	463	356	488	436	321	406
340	464	357	491	440	321	406
350	465	358	493	443	320	405

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.6 Volume Estimates for Managed Stands

A batch version of the Table Interpolation Program for Stand Yields (Batch TIPSY version 2.1, alpha 5), supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed coniferous stands. Deciduous stands remained on VDYP yield tables.

The area-weighted site index for each analysis unit, along with the regeneration assumptions in Table A-13. were used as inputs to TIPSY. Section A.4.7, "Managed stand regeneration assumptions" documents which stands were assumed to be managed in the analysis.

Table A-18. displays the volume tables for managed stands. The volume tables are assumed to stay constant beyond the ages for where data exist.

A.6 Volume Estimates for Managed Stands

Table A-18. Timber volume tables for existing and future managed stands (cubic metres/hectare)

Age (years)	0113	0123	0133	0213	0223	0233	0313	0323	0413
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	1
30	0	0	0	1	0	0	2	0	39
40	4	0	0	21	0	0	15	2	107
50	53	0	0	88	3	0	63	11	181
60	133	2	0	168	24	0	133	42	250
70	208	22	0	236	65	2	201	90	305
80	277	59	1	303	112	9	260	142	354
90	344	104	3	350	157	25	317	188	393
100	391	152	16	383	196	49	361	229	423
110	424	191	36	409	235	77	392	270	448
120	448	229	61	429	272	106	417	306	466
130	467	265	90	444	301	135	437	335	480
140	482	303	120	457	324	159	454	357	480
150	494	333	150	457	341	182	468	376	480
160	503	359	175	457	356	204	479	390	480
170	508	378	199	457	367	227	487	402	480
180	506	393	223	457	378	249	489	413	480
190	505	406	245	457	386	266	491	422	480
200	504	417	269	457	393	282	493	430	480
210	504	426	292	457	400	295	494	437	480
220	504	434	312	457	405	305	495	442	480
230	504	440	328	457	409	314	495	446	480
240	504	445	344	457	413	322	495	450	480
250	504	450	356	457	416	329	495	452	480
260	504	454	365	457	416	334	495	452	480
270	504	457	374	457	415	340	495	451	480
280	504	459	382	457	414	344	495	451	480
290	504	461	388	457	413	348	495	450	480
300	504	461	388	457	413	348	495	450	480
310	504	461	388	457	413	348	495	450	480
320	504	461	388	457	413	348	495	450	480
330	504	461	388	457	413	348	495	450	480
340	504	461	388	457	413	348	495	450	480
350	504	461	388	457	413	348	495	450	480

(continued)

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.6 Volume Estimates for Managed Stands

Table A-18. Timber volume tables for existing and future managed stands (cubic metres/hectare)

Age (years)	0423	0433	0513	0523	0613	0623	0633	0713	0723
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	12	1	20	1	0	0	0	3	0
40	51	16	88	11	2	0	0	20	1
50	105	45	178	45	20	0	0	76	3
60	160	83	256	95	74	2	0	150	18
70	211	124	326	147	142	14	1	216	49
80	255	162	384	195	203	43	3	277	89
90	294	194	432	236	259	81	18	329	132
100	325	224	469	273	317	124	43	367	170
110	351	252	474	304	361	165	72	396	205
120	372	276	479	331	394	201	104	419	238
130	390	297	482	355	418	235	139	437	270
140	405	312	484	374	437	268	169	452	296
150	419	325	486	392	452	302	196	463	318
160	430	337	487	408	464	329	223	470	334
170	441	346	489	421	475	353	247	473	349
180	448	355	490	433	482	371	275	475	360
190	452	362	491	443	488	385	300	475	370
200	455	369	491	451	494	398	320	475	378
210	457	375	491	457	495	407	338	475	385
220	459	380	491	462	493	416	354	475	391
230	462	385	491	468	491	424	365	475	397
240	463	389	491	472	490	430	375	475	401
250	465	392	491	476	488	435	385	475	404
260	467	393	491	480	486	439	392	475	407
270	467	394	491	484	484	444	398	475	410
280	467	394	491	486	482	446	404	475	413
290	467	395	491	489	480	448	410	475	413
300	467	395	491	489	480	448	410	475	413
310	467	395	491	489	480	448	410	475	413
320	467	395	491	489	480	448	410	475	413
330	467	395	491	489	480	448	410	475	413
340	467	395	491	489	480	448	410	475	413
350	467	395	491	489	480	448	410	475	413

(continued)

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.6 Volume Estimates for Managed Stands

Table A-18. Timber volume tables for existing and future managed stands (cubic metres/hectare)

Age (years)	0733	0813	0823	0903	1013	1023	1033	1113	1123
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	0	0	0	16	1	0	0	0
40	0	1	0	0	68	23	0	1	0
50	1	25	1	1	120	61	3	22	1
60	3	81	14	15	167	98	17	76	15
70	10	145	46	51	211	133	36	139	49
80	30	200	91	94	247	163	54	194	94
90	59	253	137	141	279	190	70	245	140
100	91	301	177	179	305	213	85	294	180
110	124	338	214	217	326	231	98	332	218
120	155	365	252	253	344	247	108	360	256
130	181	387	286	287	358	259	116	382	289
140	207	405	312	313	369	269	122	400	316
150	232	419	333	334	379	278	127	415	335
160	256	432	349	351	385	284	130	428	351
170	276	442	362	365	391	288	132	438	364
180	293	450	373	377	396	292	134	446	376
190	307	457	383	388	399	295	136	453	385
200	319	458	390	397	404	299	138	456	393
210	330	459	397	404	408	302	139	457	399
220	338	460	404	412	412	306	141	458	405
230	345	462	408	418	416	309	143	459	410
240	351	463	412	423	420	312	144	460	413
250	357	464	415	428	423	315	145	461	417
260	361	464	418	432	424	316	146	461	420
270	365	465	420	436	425	316	146	462	420
280	368	466	418	436	425	317	147	463	419
290	372	465	417	436	426	317	147	462	418
300	372	465	417	436	426	318	147	462	418
310	372	465	417	436	427	318	148	462	418
320	372	465	417	436	427	318	148	462	418
330	372	465	417	436	428	318	148	462	418
340	372	465	417	436	428	319	148	462	418
350	372	465	417	436	428	319	148	462	418

(continued)

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

A.6 Volume Estimates for Managed Stands

Table A-18. Timber volume tables for existing and future managed stands (cubic metres/hectare) (concluded)

Age (years)	1213	1223	1303	1403
10	0	0	0	0
20	0	0	0	0
30	0	0	1	2
40	0	0	8	21
50	4	0	39	69
60	36	1	85	124
70	83	11	136	176
80	135	39	182	217
90	180	73	221	252
100	223	109	254	281
110	265	145	282	302
120	301	175	307	318
130	330	204	327	331
140	352	233	344	339
150	371	261	358	346
160	386	284	370	348
170	399	304	380	347
180	410	319	388	344
190	420	333	395	341
200	429	344	400	337
210	435	353	404	333
220	442	362	406	329
230	447	369	407	327
240	453	375	407	325
250	454	380	407	324
260	454	385	406	322
270	455	390	405	319
280	455	393	404	317
290	456	396	403	315
300	456	396	403	315
310	456	396	403	315
320	456	396	403	315
330	456	396	403	315
340	456	396	403	315
350	456	396	403	315

AU legend:

1st and 2nd digit = AU number (01-14)

3rd digit = productivity rating (G = 1; M = 2; P = 3; all = 0)

4th digit = stand class (thrifty = 1; old = 2; managed = 3)

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The report identifies employment and income impacts, changes in government revenues, and community impacts at various harvest levels and times in the future. This type of analysis requires several assumptions of which the reader should be aware. Some of these assumptions are outlined below:

- **Employment multipliers** — the multipliers used in the analysis of indirect and induced impacts are based on analytical assumptions and estimated using data collected at a certain time, thus they reflect industry and employment conditions at that time. Consequently, they may not accurately reflect future industry conditions. While generally sound indicators when based on fairly recent information, older multipliers may not reflect the industry under examination. In any impact analysis, the information should be considered as an order of magnitude indicator.
- **Employment coefficients** — employment impacts associated with future harvest levels are calculated using employment coefficients (person-years per 1000 cubic metres). This approach assumes that the industry structure will be the same in future as it is today. While reasonably accurate in the short term, employment coefficients may change due to changing market conditions or production technologies, for example.
- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While fairly accurate for the harvesting sub-sector, this may not be the case for the processing and silviculture sub-sectors of the forest industry. Additionally, indirect and induced impacts will likely occur over a longer period of time, as business and consumer spending levels adjust.
- **Processing thresholds** — impacts on processing jobs are unlikely to occur in direct proportion to harvest changes (i.e., a 10% harvest reduction may not lead to a 10% processing employment reduction). Impacts related to processing thresholds are more likely to occur step-wise. A processing threshold is the level of a mill's timber supply where, when reached, will cause a mill to either lay off a shift or shut down the mill, temporarily or permanently. Accurately predicting a mill's threshold level is not possible. As a result, the analysis may overestimate processing impacts if mills continue to operate the same number of shifts, but perhaps at lower production levels. Alternatively, the analysis could underestimate impacts if a mill were to eliminate a shift. Over the medium- to long-term the impact figures should be reasonably accurate, however.
- **Government expenditures** — provincial government expenditures are more related to population levels than to industry activity. As such, expenditures on education, health care, and other government services are assumed to not change despite harvest changes and any subsequent change in government revenues. However, public expenditures would likely change if community population levels change sufficiently. This change would amplify the community impacts of forestry job losses or gains.
- **Proportional harvest reductions** — harvest reductions are assumed to be spread evenly among all licensees and all forms of tenure.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators, and processing facilities in the TSA. Other general economic data are from BC STATS, the B.C. Ministry of Finance and Corporate Relations, Statistics Canada, and local communities.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is a full-time job that lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1) harvesting;

2) silviculture; and,

3) timber processing.

The procedure for estimating employment and income impacts involves several steps. First, current activity in each of the three sub-sectors was assessed. Then, indirect and induced employment and employment income impacts were estimated using data from the B.C. Ministry of Finance and Corporate Relations and Statistics Canada. Next, employment coefficients were calculated and applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes, were also calculated using B.C. Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log transport, log salvage, planning, and administration functions. While road building and maintenance work are important activities in the forest industry, the employment multipliers used in this analysis define these activities as indirect rather than direct. Therefore, road building and maintenance employment are not included in the direct impact estimates, but are captured in the estimates of indirect impacts. Including these as direct would double-count and overestimate employment impacts.

Data on employment, place of residence, and timber flows were obtained through a survey of licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of residents *versus* non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1) TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and,

2) Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning, and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, silviculture jobs were converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who lived within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production, and sources of timber was gathered from TSA mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber requirement was supplied by the harvest from the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest.

Employment figures were also adjusted to reflect the residences of workers (i.e., those who lived within the TSA and those who lived outside the TSA). Employment in timber processing that is supported by chip by-products from milling operations was similarly estimated.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector refers to those who provide goods and services to firms directly engaged in the basic forestry sector (for example, those who provide road maintenance services). Induced employment refers to those who provide the goods and services purchased by employees who are directly and indirectly engaged in the industry (for example, those who work in retail outlets). Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the B.C. Ministry of Finance and Corporate Relations.

Two sets of employment multipliers were used for this report: migration multipliers and no-migration multipliers. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that a displaced worker remains in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

B.2 Economic Impact Analysis Methodology

The TSA and provincial employment multipliers used in the Robson Valley TSA analysis are shown in Table B-1.

Table B-1. Total employment multipliers

Forest sub-sector	TSA migration multiplier	TSA no-migration multiplier	Provincial interior migration multiplier	Provincial interior no-migration multiplier
Harvesting	1.49	1.35	2.14	1.80
Solid wood processing	1.32	1.26	2.29	1.93
Pulp	N/A	N/A	3.02	2.48

Sources: Horne, G., R. Riley, L. Ransom, and S. Kosempel. 1996. A provincial impact estimation procedure for the British Columbia forest sector. B.C. Ministry of Finance and Corporate Relations, Victoria, B.C.

B.C. Ministry of Finance and Corporate Relations. 1999. The 1996 forest district tables.

N/A: not applicable.

Employment estimates of alternative timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices, and forest management assumptions and will not likely reflect industry operating conditions far into the future. Therefore, the employment estimates should be viewed as indicators of the general size of change rather than as precise estimates of changes in employment levels.

Employment income estimates

Employment income was calculated using average income estimates for workers in the forest industry. Income data are from Statistics Canada Survey of Employment Payroll and Hours. From 1995 to 1997, the average pre-tax annual income (less benefits) for sub-sectors of the forestry sector associated with the Robson Valley TSA was approximately $44,550 for logging and forestry services; $44,915 for solid wood manufacturing; and $52,250 for the pulp and paper sector. The weighted average annual income for direct forestry workers was $46,390. The average annual income for indirect and induced employees averaged about $34,070. This figure is based on a selection of business and personal service sectors, accommodation, food and beverage sector, and the construction sector average annual wages. Income taxes were calculated based on marginal tax rates of 23-28% with one-third of the total income tax accruing to the province.

Provincial government revenues

Except for stumpage, royalty, and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated. See Table B-2.

Table B-2. Robson Valley TSA provincial government revenue estimates

	Average revenue 1996–1998 ($1998 millions)	Revenue ($/'000s m^3)
Stumpage, rents, and royalties	8.6	17,800
Industry taxes	4.4	9,037
Provincial income tax	3.7	7,660
Total government revenues	16.7	34,497

Source: B.C. Ministry of Forests. Price Waterhouse.